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A MONOGRAPH OF SUGAR-CANE VARIETIES

by

ARTHUR H. ROSENFELD
Special Technologist for Cane, Insular Experiment Station of Porto Rico

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Foreword

and

"The Varietal Revolution in Porto Rico"

by

Hon. Carlos E. Chardón,
Commissioner of Agriculture for Porto Rico

With General Observations and Descriptions of 62 Varieties by

F. S. EARLE,
Former Expert in Cane Diseases at the Insular Experiment Station.

Descriptions of 110 Additional Varieties by the Author and

Luis A. Serrano,
Assistant Agronomist at the Insular Experiment Station.

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50 Varietal Drawings in Color by

Mario Brau de Zuzuarregui
Director Museum of Porto Rico.

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FOREWORD

The author has suggested that a few introductory remarks be written for his excellent "Monograph of Sugar Cane Varieties". His request is complied with with great pleasure. He needs, however, no introduction to the sugar world: Mr. Rosenfeld's wide experience with cane cultivation in the past decade, can hardly be equalled by any other single man. His field of action has covered a vast territory: Tucumán, Porto Rico, Perú, occasional visits to Cuba, and, finally, Louisiana.

His much-needed book is the outcome of the substantial work started by professor F. S. Earle in 1919. It is indeed, as the author states, a continuation of a work that can justly be considered as a monument in the world's sugar history. As a successor of Prof. Earle, Mr. Rosenfeld has proven to be a worthy follower; in fact, we doubt it any other man could have interpreted better the ideas and plans of the "grand old man".

Their work is now bearing fruit, and our sugar industry is reaping a prodigal harvest. For the benefit of those business interests who would like to realize the full extent of the results achieved, I am publishing a paper entitled "The Varietal Revolution in Porto Rico". It shows results from a large commercial standpoint.

Mr. Rosenfeld's work should be continued. It is a landmark in the history of cane cultivation, an invaluable contribution to the economic welfare of the West Indies, and an inspiration to all his colleagues. Let us all hope that it will stimulate workers in other corners of the globe, so that our knowledge on cane varieties, which so vitally affects sugar production, will be more widely diffused, and better information secured as to their behavior and general cultural characters.

CARLOS E. CHARDÓN.

DEDICATION

To His Excellency, the Hon. Horace Mann Towner, Governor of Porto Rico, this work is dedicated with the sincere respect due him from the Department of Agriculture and Labor for his unfailing support and keen personal interest in the successful development of this very important feature of the Insular Government's activities.

HON. HORACE MANN TOWNER, Governor

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THE VARIETAL REVOLUTION IN PORTO RICO *

By CARLOS E. CHARDÓN,
Commissioner of Agriculture and Labor of Porto Rico

Porto Rico's Sugar Production.

American and Cuban sugar interests have lately shown a desire to know what has been going on in Porto Rico during the past few years that could explain the large increase in the Island's sugar crops. A small island like beautiful Borinquen with all her available sugar lands taken up since many years ago, contrary to all expectations, has achieved a spectacular rise in her crops of 1925 and 1926, and will surely continue to increase her sugar crops in her successful fight of lowering the cost of production of her sugar by increasing the production per unit of surface.

The following is the Island's sugar production for the last twelve years (tons of 2,000 pounds):

1915	346,490	1921	489,817
1916	483,589	1922	408,335
1917	505,081	1923	379,171
1918	453,793	1924	447,597
1919	406,002	1925	660,411
1920	485,070	1926	603,240

1927 (Department of Agriculture and Labor estimate)	612,000
1927 (Sugar Producers' Association estimate)	621,000

These figures show that the average for the last two crops and the estimate for the present is 625,217 tons, while the average production of the preceding 10-year period is 440,293 tons, which means an increase of 42.1 per cent.

American and Cuban interests are justified in their inquisitive look for the real cause of this remarkable increase, not for fear of its effect in the world's sugar production, since our entire output is too small to materially affect the price situation, but for the objective lesson that the larger Antille could learn from her smallest but more industrious sister, Porto Rico.

* Paper presented at the International meeting of the Association of Sugar Technologists held in Havana, March 1927.

What has been going on here then? The present article endeavors to answer the dilemma in a clear light.

Factors Affecting our Sugar Production.

The principal factors that need to be considered in our sugar production are four as follows:

1. Acreage.
2. Rainfall precipitation.
3. Mosaic.
4. Varietal selection.

As already stated, all our available sugar lands have been taken up and cultivated since many years back, so it must be expected that acreage fluctuations will be slight. This appears to be the case. The figures in the Insular Treasury Department follow:

1915	211,110 acres
1916	203,491 acres
1917	205,106 acres
1918	256,431 acres
1919	238,901 acres
1920	240,151 acres
1921	241,372 acres
1922	244,180 acres
1923	239,676 acres
1924	236,600 acres
1925	240,010 acres
1926	242,745 acres

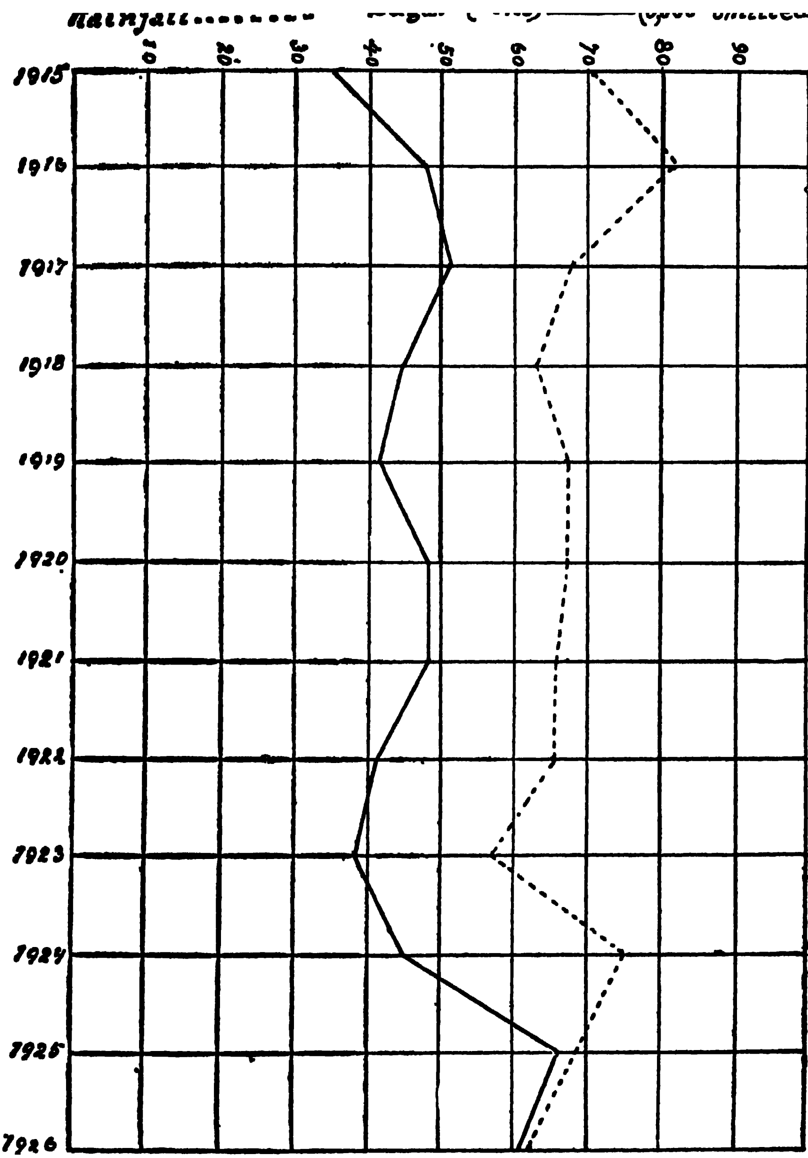
The large increase for 1918 is not all due to increased planting, but to a general revision of the property ordered by the Governor, which revealed many small farms which had gone into cane since the War.

Thus the acreage fluctuations, which have been indeed slight, can not be accounted for materially affecting our sugar crops.

The rainfall precipitation appears to be a very strong factor in production. This is especially so for our dry south coast, where the largest mills are located. Appendix I will show the precipitation in the Island by sections (north, east, south and west) since 1915.

It is easy to correlate our sugar crops to the rainfall precipitation. In fact, Plate A will show graphically, that a distinct correlation existed for the years 1915 to 1925 inclusive. In the present crop of 1927 an unusual thing has happened: despite a decreased rainfall for the preceding year, the crop will be appreciably larger than last year's thus proving that another factor besides rainfall is influencing our production—namely, the new cane varieties.

Plate A.



Porto Rico—Relation of Rainfall and Sugar Crops

The writer became interested in watching the growth of the Island's sugar production, since 1925, when the crop suddenly rose, from 447,570 tons in 1924 to 660,003 tons during that year, showing an increase of 47.4 per cent. The causes for such increase received careful study from the writer and they were briefly explained in his report to the Governor of Porto Rico[1] as follows:

"Several factors have contributed to the increase of our crop. In November 1924, a questionnaire was sent around inquiring as to the causes for this increase. Answers were very promptly received from all the mill managers, which have enabled the Department to draw very interesting conclusions.

"All of them reported that the increase in the crop was due largely to very favorable weather conditions. This has been true all over the Island.

"Seventeen mill managers stated that the propagation of high-sucrose-yielding varieties also contributed to the increase of their crops. Most of them mentioned the well-known and famous B.H. 10(12) and S.C. 12(4), as yielding the highest records in sugar. These two varieties are by far the most popular among our growers and they have been planted extensively.

"Thirteen mill managers report that the increased production has been due to the propagation of the immune Uba and other varieties highly resistant to the mosaic. These sections are mostly in the western section or in the Arecibo valley, where the ravages of mosaic were most severe."

The influence of the varietal factor has kept increasing from 1925 on and in 1926 the crop was 603,240 (with 68.37 inches of rainfall the preceding year). Normally, that same precipitation and an equal acreage produced 485,070 tons in 1920 and 489,817 tons in 1921. Still further, for the present crop of 1927 (with only 62.67 inches of rainfall the preceding year) estimated production has been figured at 612,000 to 620,000 tons.

These figures consistently prove the importance of the varietal factor—in fact, what this factor has already occasioned to the Island's sugar production, and what it may bring in the future, fully justifies the title of this paper, "The Varietal Revolution in Porto Rico." Agriculture as a rule is a science of slow evolutionary progress, but in our case, the changes and material benefits derived from it have been so sudden that only the word "revolution" with all its dynamic meaning can fully convey the real nature of the blessings which beautiful Borinquen has received in recent years.

The Mosaic Disease: A Threatening Cloud.

In 1915, an unknown and mysterious disease appeared in Arecibo extending well into the hilly section to the west of the town. Its effects on the cane were very evidently causing a stunting of the growth, while the symptoms in the leaves were a yellow mottling

[1] Chardón, C. E. The Present High Crop. *In* Annual Report of the Comm. of Agr. and Labor for 1924–25: Pages 7–10 1926

or chlorotic appearance of the same. It was known for some time as Yellow-Stripe disease, while in Spanish it was popularized as *matizado*. The disease attracted world-wide attention following the publication of Stevenson's paper is "Phytopathology".[2]

The mysterious disease spread rapidly and in 1918 had invaded practically three-fourths of the entire sugar area of the Island. The actual losses, not very evident during the crops of 1916 and 1917 on account of the abnormally good precipitation, were disheartening for the crop of 1918. Stevenson[3] estimated the loss at $2,500,000 for 1918, while those of 1917 he placed at $500,000. In fact, the whole northeastern and western sections of the Island were on the verge of a complete breakdown.

In August 1918, Professor F. S. Earle was commissioned by the United States Department of Agriculture to come down and investigate the disease with instructions to cooperate with the Federal and Insular Experiment Stations. Professor Earle's visit to the Island marks a most important event in the history of our sugar industry. His far-reaching insight of the situation as well as the practical application of control measures which shortly followed, pointed the way out to the final solution of the dilemma. Shortly after Earle's arrival an important headway towards the comprehension of the disease was made: The mysterious "yellow stripe" was found to be identical with the mosaic of Hawaii and the "Gelestrepenziekte" of Java.

The importance of the testing of varieties for resistance to mosaic was early realized by Earle and an extensive experiment was tried at Santa Rita in cooperation with Russell & Co.; 171 different varieties were tested in the field. This experiment whose results were published by the Insular Experiment Station,[4] conclusively proved the immunity of the Uba cane to mosaic. Other varieties proved to be quite resistant, among which were P.O.J.–36 and P.O.J.–234. The rest were either as susceptible as Cristalina and Rayada or more so.

Earle's statement in connection with the Uba, or Kavangire, was as follows:

"This cane was first observed last August in the variety plots at the Federal Station at Mayagüez where it alone was perfectly healthy out of a list of 44 kinds. These plots however had not been planted with special reference to the

[2] Stevenson, J A An Epiphythotic of Sugar Diseases in Porto Rico. Phytopath: Vol 7· 418–425 1917.

[3] Stevenson, J A The Mottling or Yellow Stripe Disease of Sugar Cane Journ Dept. Agr P R Vol 4, No 1· 7 1919

[4] Earle, F S The Resistance of Cane Varieties to the Yellow Stripe or Mosaic Disease Insular Experiment Station Bul. No 19. 1919.

disease and the doubt arose whether or not this apparent immunity might be accidental. It was the necessity for deciding this point that first suggested the planting of the Santa Rita experiment the results of which are given in this paper. This original plot was harvested last January yielding at the rate of over seventy tons per acre—far more than any of the other kinds in these plots. It ratooned heavily and has again remained entirely healthy. This with the very severe test at Santa Rita, where ninety other kinds planted at the same time became almost completely diseased within two months after germination, seems to settle the question and we must consider the Kavangire as absolutely immune to the yellow stripe or mosaic disease,'' (p. 13).

He concludes his paper with the following statement:

''This preliminary experiment shows clearly our great need for a much more comprehensive knowledge of cane varieties. It is to be hoped that the work may be continued until we know not only the comparative resistance and susceptibility of all the different kinds to the mosaic disease, but what is equally important, to the root disease and to the cultural requirements of all our numerous soil conditions.''

Thus the Santa Rita immunity experiment brought out the varietal problem as of supreme importance to the Island's sugar industry. A preliminary paper by Earle[5] had already appeared that same year (1919) opening for discussion the whole subject of sugar-cane varieties. It may be interesting to know so as to serve as a basis for comparison the general status of cane varieties in the Spring of 1919, as pictured in said publication, and from other sources obtained by the writer:

Rayada—(Striped Cheribón) was holding first place, prevailing in all the northern and western districts and also commonly found in the south and east.

Cristalina—was second in acreage, being most abundant on the southern coast and in the Fajardo district.

Cavangerie—a markedly hardy cane for poor, worn-out soils, followed in acreage, especially in the Isabela district and in the hilly lands of the north coast, but in mosaic-infected regions it was rapidly breaking down with the disease.

Yellow Caledonia—held fourth place. It was quite popular in the Fajardo and Naguabo districts, and was being rapidly extended in the Arecibo and Plata valleys on the north coast, and in the low swampy lands of the San Germán valley.

Otaheite or ***Blanca***—held fifth place in acreage, being the favorite cane in the Yauco valley and various other districts of the south coast.

[5] Earle, F. S. Varieties of Sugar Cane in Porto Rico. Journ. Dept. Agr. Vol. 3, No. 1919.

Imported seedling cane were quite unpopular at that time except in a few well-managed and progressive centrals. "Mercedita" was going strongly for B-208, while "Guánica" had a few hundred acres planted to D-117 and B-3412. "Fajardo" was trying various seedling canes, D-109, and Sealy Seedling holding very well in the hilly lands, while D-433 was just commencing to show up as a superior cane.

To sum up the situation in 1919, by far the greatest bulk of the acreage, over 98 per cent conservatively speaking, was planted to varieties all of which excepting *Yellow Caledonia* had been under cultivation in the Island for many generations. Seedlings were unpopular but an advance stand had been taken by a few progressive centrals.

With this general situation prevailing, a conscientious study of sugar-cane varieties was imperative and that was the task imposed upon Earle. A large collection of seedling varieties was being grown by the Insular Experiment Station so that there was ample material to study; furthermore, the various centrals which has propagated a few of them were very willing to cooperate in the work.

The "Sugar-Cane Varieties of Porto Rico—II" appeared in 1921, in the July number of the Insular Station Journal.[6] It was a voluminous and careful work discussing all the popular varieties and most promising seedling canes. In the discussion of the Uba cane, Earle says (p. 65):

> "It seems certain that the serious outbreak of mosaic disease on the west coast can be easily and quickly dominated by the use of this variety."

The popularity which the Uba attained in the next few years is worthy of a special comment.

The Uba: An Emergency Cane.

This variety originated in northern India, from where it was carried to Mauritius and Natal in South Africa, where it came to be known as *Uba*. During the heavy gumming-disease epidemic in Brazil, late in the 60's it was taken to that country and from there to Argentina, where it never received any note, owing to their short growing season. It was imported to Porto Rico from the Tucumán Station through the office of the Bureau of Plant Industry in 1918, and the first shipment was planted at the Mayagüez Station where it attracted Prof. Earle's attention for its apparent immunity. Another shipment followed next year, which was equally distributed between the Mayagüez and the Río Piedras Stations.

[6] Earle, F. S. Sugar-Cane Varieties of Porto Rico—II. Journ. Dept. Agr. P. R. Vol. 5, No. 3. 1921.

After the severe immunity test at Santa Rita, the Uba came into prominence as a possible remedy for mosaic in the whole western coast, but it was looked upon with reluctance by the planters owing to its thinness. In the meantime the mosaic was causing a complete breakdown of the whole western coast of the Island. See Appendix II, sections under Pagán District and San Germán Valley, and Appendix III, showing records of Central "Eureka". The tonnage per acre in the San Germán valley was reduced from 15.46 in 1920 to 10.08 in 1922; while that at "Eureka" dropped suddenly from 14.50 in 1920 to 8.00 in 1921, and continued at 8.30 in 1922. Conditions in the Pagán District and in the entire valley where "Coloso" is emplaced were quite similar. The year 1921 was the critical period for the whole western section of Porto Rico, the sudden fall in the prices and the complete breakdown of the field occasioned by mosaic was threatening disaster, when Earle's statement, "It seems certain that the serious outbreak of mosaic disease on the west coast can be easily and quickly dominated by the use of this (Uba) variety", was announced in the JOURNAL. Plate II shows the mosaic infection at its highest in 1921. The situation of our western planters fell short, if the writer may be allowed to establish a comparison, of the desperate situation of the French in Verdun, but here, the unassuming Uba instead of immortal Petain was repeating the glorious phrase. *"Ne passcront pas."*

The only alternative, then, was *Uba nor nothing.* The results showed that Uba saved the day. In two years, practically the whole western coast was replaced by Uba, and the results by far exceeded all expectations. A few authentic figures will indicate how successful was the victory.

Year	Situation	Pagán District	San Germán	Eureka
1917	No mosaic	16.24 tons.	15.78 tons.	....
1920	Heavy mosaic	12,52 tons.	15.46 tons.	14.50 tons.
1921	Heavy mosaic Uba started in Pagán	12.40 tons.	13.24 tons.	8.00 tons.
1922	Heavy mosaic in others. Uba in all of Pagán	15.30 tons.	10.08 tons.	8.30 tons.
1923	Started in other two	24.68 tons.	16.41 tons.	14.16 tons.
1924	Uba supreme	29.84 tons.	24.51 tons.	20.22 tons.
1925	Uba supreme	26.49 tons.	29.49 tons.	19.85 tons.
1926	Uba supreme	26.72 tons.	23.72 tons.	21.00 tons.

It may be seen from the above table that the tonnage was doubled and even trebled by the use of Uba. It was a case of emergency, and planters did not stop to think of the troubles that were coming to them from the factory, as a result of the low juices of Uba, together

with other undesirable milling qualities of that cane. The Insular Experiment Station undertook the task of comparing all the factory yields of the mills that were grinding Uba and the results were published by López Domínguez[7] in bulletin form. Controversies between *colonos* and the mills continued until a sucrose scale was finally worked out by the interested mills.

Together with the rise of the Uba, as an immune variety, several P.O.J. canes came also into prominence in the mosaic-infected sections. One of them was a so-called "Egyptian cane", and which turned out to be P.O.J.–105, and also P.O.J.–213, and P.O.J.–234. All these canes had also been imported from the Tucumán Station but were completely infected with mosaic. Their tolerance to the disease, however, was very marked and they rapidly spread over the western coast and the Arecibo valley. They soon became intolerably mixed up, especially the P.O.J.–36 and P.O.J.–213, but Dr. Rosenfeld, who had recently arrived at the Insular Station as Cane Technologist, with his valuable experience in Tucumán, worked out their correct distinctions and published a very interesting work "The Java P.O.J. Canes in Tucumán and Puerto Rico",[8] which finally led to our losing such a valuable acquisition by inducing the Louisiana Sugar interest to offer Rosenfeld an enviable chance of working out for them something similar to what he helped to do both in Tucumán and Porto Rico.

Coming back to the Uba, a serious attempt is now being made to replace it with a variety that would yield more sugar. The Java canes are richer in sugar than the Uba, but there is a growing tendency among the Uba and even the P.O.J. planters to come back to the thick canes. This is especially so in the last year and in the present, when the fame of thick canes, like BH–10(12) and SC–12(4), have continuously tempted them to go back to thick canes. But these varieties are quite susceptible to mosaic. P.O.J.–2725, a nice, thick cane, practically immune to mosaic, attracted a great deal of attention last year, but its sugar content is not very high; and it arrows freely; this has been a disappointment to planters.

Just what will happen to the old western coast of Porto Rico is not known, but the writer is inclined to think that the temptation to plant BH–10(12) and SC–12(4) will be so increased, that they will eventually adopt them for general field practice in the lowlands, while the Javas will continue to be planted in the hills. Central "Cambalache", in the Arecibo valley and situated in a very heavily

[7] López Domínguez, F. A. The Sugar Yield of the Uba Cane in Porto Rico. Insular Exp. Sta. Bul. No. 28. 1924.

[8] Rosenfeld, A. H. The Java P.O.J. Canes in Tucumán and Porto Rico. Journ. Dept. Agr. Vol. 8, No. 3. 1924.

infected mosaic district, long ago fell to the temptation of planting BH-10(12) and SC-12(4), as announced by the writer two years ago.[9] Although the yields have been very satisfactory the mosaic has become so general as to constitute again a serious problem for the future.

Losses Occasioned by Mosaic.

In 1921, Figueroa[10] made an attempt to estimate the amount of losses occasioned by the mosaic disease. He divided the Island in regions of: (*a*) no mosaic, (*b*) slight mosaic infection, (*c*) medium mosaic infection, and (*d*) heavy mosaic infection. He could trace a distinct fall in production in regions of heavy and medium mosaic infection. The exact amount of losses he did not determine but he clearly sated that they run well into the millions.

The writer has continued Figueroa's work up to 1926. (See Appendix IV.) Let us explain briefly the situation by drawing an example: The combined crops of 1916 and 1917—which were the highest up to that time—are taken to represent a production of 100 per cent.

The crops of 1918 and 1919 show marked reductions which had been due both to decreased rainfall and mosaic. There is no doubt that the mosaic was as powerful a factor as rainfall in reducing the crops from 503,081 tons in 1917 to 453,081 tons in 1918 and to 406,002 tons in 1919. The following figures will prove it:

Zones	Infection	1916 & 1917	1918	1919
Second Zone	Heavy mosaic	51,057 tons 100%	38,929 tons 76.2%	30,592 tons 59.9%
Third Zone	Heavy mosaic	29,456 tons 100%	21,896 tons 74.3%	19,638 tons 66 6%
Fourth Zone	Medium mosaic ..	88,608 tons 100%	86,367 tons 97.4%	70,624 tons 79.7%
Fifth Zone	No mosaic.........	97,256 tons 100%	102,446 tons 105.3%	92,357 tons 94 9%
Seventh Zone ..	No mosaic...	72,623 tons 100%	75,645 tons 104 1%	66,917 tons 92.1%

These figures show that in 1918, zones fifth and seventh showed slightly increased production, but the decreased production of heavily infected areas brought about a general decrease. In 1919, the drought enters in as an important factor, causing zones fifth and seventh to

[9] Chardón, C. E. Mosaic Investigation at Central Cambalache. *In* Miscellaneous Papers on Sugar-Cane Technology. Journ. Dept. Agr. P. R. Vol. 8, No. 2: 27–39. 1924.
[10] Figueroa, C. A. The Mottling Disease of Cane and the Sugar Production of Porto Rico. Journ. Dept. Agr. P. R. Vol. 3, No. 4: 35–41. 1919.

fall down, but the decreased production in mosaic zones is very alarming.

The crops for 1920 and 1921 are again high—485,070 tons and 489,817 tons respectively—due to favorable weather, but the increase is to be credited (see Appendix IV) to high increases in zones of no mosaic. Zones with heavy mosaic continued giving ridiculous yields.

And so it contiuued up to the present, when the varietal factor has brought about the revolution which is the subject of the present paper. Appendix V is a condensed summary of Appendix IV, in which the mosaic influence can be more clearly traced.*

To sum up the mosaic experience in Porto Rico, the writer feels justified in placing the correct amount of losses at a figure between $8,000,000 to $10,000,000. This figure is conservative.

The BH-10(12) and SC-12(4) Canes.

Both of these cane varieties were produced in Barbados by John R. Bovell, to whom the sugar world owes an eternal debt of gratitude. Strange enough, but by mere coincidence, both canes have B-6835, as a female parent. SC-12(4) bears the name "Saint Croix" instead of the B—meaning Barbados—because it was taken as a young seedling to Sant Croix in a visit which Bovell made to that island in 1912 and presented to the Danish authorities as a gift which later proved to be worth millions.

BH-10(12) was bred in 1910 and a few years later became widely popular in the British West Indies. For details on the behaviour, cultural characteristics and other information on these two canes see Rosenfeld's paper [11] published by the Insular Experiment Station.

BH-10(12) was imported to Porto Rico in 1919, jointly by Guánica Central and the Insular Experiment Station although "Mercedita" claims to have imported some, as early as 1917. SC-12(4) was imported in 1919 by the Federal Experiment Station.

To Central "Mercedita" of Ponce, however, belongs the credit of being the first to realize the importance of the varieties BH-10(12) and SC-12(4) as great sugar-producing canes for the south coast. In Appendix VI is shown the complete record of the acreage in varieties with their respective sugar production since 1917. At that time, fully four-fifths of the total acreage was planted to Cristalina and Otaheiti canes. Practically the entire south coast was planted to these two canes, with the former predominating over the latter.

[11] Rosenfeld, A. H. The BH-10(12) and SC-12(4) Canes. Journ. Dept. Agr. P. R., Vol. 9, No. 3. 1925.

* Appendix V is not published here.

GRAPHIC REPRESENTATION OF INCREASED PRODUCTION

IN AGUIRRE AND ALLIED CENTRALS

"Aguirre" Central
5-year Average
Cristalina

1926
54% B. H. 10(12)
S.C.12 (4)

1927 (Est.)
90% B.H. 10 (12)
S. C. 12 (4)

"Cortada" Central
5-year average
Cristalina

1926
45% B.H. 10(12)
S.C. 12(4)

1927 (Est.)
89% B.H. 10(12)
S.C. 12(4)

"Machete" Central
5-year average
Cristalina

1926
46% B.H. 10(12)
S.C. 12(4)

1927 (Est.)
96% B. H. 10(12)
S. C. 12(4)

Grand total for the three Centrals:

5-year Average 12,900 Acres 41,325 Tons Sugar

Central "Mercedita", however, had already made efforts to secure a better cane, among the Barbados seedlings. B–208 was then attracting attention for its high yields, and the variety was freely propagated, occupying fully 40 per cent of the acreage in 1920 in pure cultures. and evidently more in mixed plantings. But the spectacular appearance of a small lot of a little over 3 acres of BH–10(12) yielding 6.17 tons of sugar per acre and appearing on top of the list as the highest yielder, was destined to change, or rather revolutionize, cane growing in that central, and in the rest of the Island.

In 1921, another prize winner appeared on the stage, SC–12(4). She headed the list with 7.42 tons of sugar per acre with BH–10(12) a close second with 6.80 tons. Cristalina yielded only 4.25, while B–208 and Otaheiti gave still lower yields, 3.57 and 3.36 tons respectively. From then on, BH–10(12) and SC–12(4) were rapidly propagated until the present time when they occupy over 95 per cent of the total acreage in "Mercedita". The great increase in production accrued to these two varieties may be found by the following totals in tons per acre:

Average 5-year period 1920–1924	3.46 tons per acre
Crop of 1925	5.83 tons per acre
Crop of 1926	4.80 tons per acre

The relatively low yield for 1926, is due to the fact that cane cut was fully three months younger, because the 1925 crop was so large that cane was cut and ground until late in June. If a yield, intermediate between 1925 and 1926 is taken as a basis for calculation, say 5.31 tons, its difference with the Cristalina, B–208, Otaheite mixture for the preceding 5-year period would be 1.85 tons increase, which for 3,200 acres would be 5,920 tons of sugar annually. With sugar at $4.67 New York, this increased production would mean $532,800 additional gross income.

The record achieved by BH–10(12) and SC–12(4) at the centrals belonging to the "Aguirre" interests, namely "Aguirre" proper, "Machete" and "Cortada" is equally remarkable. Here, the experiment has been carried on a much larger scale, the extension being over 13,000 acres. The change in varieties in these three mills has been so sudden that in less than three years over 90 per cent of the field has been changed from Cristalina to BH–10(12) and SC–12(4). It may be interesting to note here that all the BH–10(12) now planted in the Aguirre fields may be traced back to 13 bags of seed from the Insular Station which Prof. Earle took there in 1921. What this

change means to the Aguirre interests can be evidently demonstrated from the following figures taken from Appendix VII:

''Aguirre'' Central (Administration cane):

Preceding 5-year average Cristalina	8,000 acres	3.25 tons*	=	25,000 tons
1926—Cristalina	5,226 acres	3.47 tons	=	18,134 tons
B.H. 10(12)	2,336 acres	5.71 tons	=	13,338 tons
S.C. 12(4)	461 acres	5.84 tons	=	2,692 tons
Total	8,023 acres			35,164 tons
1927—Cristalina	748 acres	3.47 tons	=	2,595 tons
(estimate) B.H. 10(12)	6,433 acres	5.71 tons	=	36,732 tons
S.C. 12(4)	670 acres	5.84 tons	=	3,912 tons
Total	7,861 acres			43,239 tons

'Cortada'' Central (Administration cane):

Preceding 5-year average Cristalina	2,400 acres	2.74 tons	=	6,576 tons
1926—Cristalina	1,351 acres	2.95 tons	=	3,985 tons
B.H. (10)12	544 acres	4.93 tons	=	2,681 tons
S.C. 12(4)	565 acres	4.71 tons	=	2,661 tons
Total	2,460 acres			9,327 tons
1927—Cristalina	310 acres	2.95 tons	=	914 tons
(estimate) B.H. 10(12)	1,627 acres	4.93 tons	=	7,841 tons
S.C. 12(4)	1,130 acres	4.71 tons	=	5,322 tons
Total	3,067 acres			14,077 tons

''Machete'' Central (Administration cane):

Preceding 5-year average Cristalina	2,500 acres	3.50 tons	=	8,750 tons
1926—Cristalina	1,420 acres	3.55 tons	=	5,041 tons
B.H. 10(12)	715 acres	5.55 tons	=	3,968 tons
S.C. 12(4)	350 acres	5.74 tons	=	2,009 tons
Total	2,485 acres			11,018 tons
1927—Cristalina	100 acres	3.55 tons	=	355 tons
(estimate) B.H. 10(12)	2,151 acres	5.55 tons	=	11,938 tons
S.C. 12(4)	277 acres	5.74 tons	=	1,568 tons
Total	2,528 acres			13,861 tons

Plate C shows graphically the increased production of the centrals "Aguirre", "Cortada" and "Machete". The 5-year average production, from 1921 to 1925 with Cristalina is shown in comparison

* Tons of sugar per acre

with the crop of 1926 and the estimate for 1927. The estimates have been prepared by the writer, based on acreage figures of BH–10(12) and SC–12(4) which have been made available to him.

Other centrals of the south coast are quickly following the examples of "Mercedita" and "Aguirre". Central "Lafayette" owning over 6,000 acres of excellent land in Arroyo and Patillas, and which for the 1926 crop had only 5 per cent improvement with the new canes, has now 47 per cent of its field planted to BH–10(12) mostly. Large *colonos* in Guayama and Salinas are also joining in the movement, and within the coming two years, practically the whole of the southern coastal plain comprising 50,000 acres of rich alluvial *vegas* will be a solid mass of BH–10(12) and SC–12(4).

The benefits derived from these improvements, judging from actual experience, will run into millions of dollars.

It may be of interest to briefly review the behaviour of BH–10(12) and SC–12(4) in other sections of the Island: the Fajardo Sugar Co., for instance. The excellent field work and management of that central is well known in the West Indies. Appendix VIII will show the sugar yields of all varieties since 1916. The Appendix shows clearly the splendid work of D–433 which began to be widely extended in 1920 and occupied fully 60 per cent of the entire acreage in 1925 and 1926. FC–306, a promising seedling, was also profusely planted but it has proven to be very susceptible to the eye-spot disease (*Helminthosporium sacchari*). The increasing sugar yields of Fajardo may be definitely traced to the extension of D–433 and FC–306, as follows:

Year	Variety	Average	Average tons of Sugar per acre (Partial)	Average tons of Sugar per acre (Total)
Average 4-year period 1916 to 1920 .... Mostly Cheribon Canes and Caledonia				2.09
1920	D-433	222.2 acres	4.07	2.51
1921	D-433	453.3 acres	2.72	1.87 dry year
1922	D-433	1,517.8 acres	3.51	2.39
1923	D-433	2,495.0 acres	2.97	2 35
	F. C. 306	24.8 acres	4.22	
1924	D-433	4,098.9 acres	3 35	2.88
	F. C. 306	71.7 acres	4.31	
1925	B H. 10 (12)	5.4 acres	5.10	3.34
	S. C. 12 (4)	317.5 acres	4.45	
1926	B. H. 10 (12)	117.[illegible] acres	4 95	3.06
	S. C. 12 (4)	15.0 acres	4.36	
	F. C. 306	703.6 acres	3.75	
	D-433	5,702.4 acres	3.00	

It seems quite safe to predict that in spite of the well-established supremacy of D-433 in the Fajardo district, BH-10(12) will replace it in the *vega* lands of the company. For the present crop of 1927 Fajardo has 506.1 acres of BH-10(12) and 69.9 acres of SC-12(4).

A change of varietal policy in the Fajardo fields will surely influence the entire section of the Island from Central "Loíza" in Canóvanas clear around the entire northeastern section to Humacao.

Concluding Remarks.

The history of sugar production in Porto Rico for the past ten years, as reviewed in the present paper, offers an interesting experience to the sugar world—especially to our sister island, Cuba. Nowhere else, has a calamity (like mosaic) brought about such a rational change in the cultivation and improvement of a crop; indeed it has been, as Rosenfeld said, a "blessing in disguise". It has been for us an education, for now, every *colono* in the Island, has awakened to the fact that after all, *only science applied to crop production* can in the end solve his problems. He knows mosaic and fears it; he knows about cane varieties and knows that the ones he has now have originated through the application of botanical science; he uses more fertilizer, he now considers the government expert as his true and unselfish friend, not the "crazy bum running after bugs". What a different man he is now from what he was ten years ago! In fact, the writer can safely asseverate that the work accomplished is worth to the Island from $10,000,000 to $12,000,000 every year, and the production limit has not yet been reached.

But this change in our *colono* has been accomplished through years of vicissitude and sad experience. It is only experience in the end that makes a man wise: but how dearly bought has that experience been!

Our larger sister, Cuba, is now facing the mosaic trouble. It has already been severe in certain sections of the Island, while in others it is rapidly spreading. Will she wait for a costly experience to guide her, or will she take advantage of the experience of her smallest sister?

APPENDIXES AND PLATES

TO ACCOMPANY

"THE VARIETAL REVOLUTION IN PORTO RICO"

BY

CARLOS E. CHARDON
COMMISSIONER OF AGRICULTURE AND LABOR
OF PORTO RICO

APPENDIX I

ANNUAL RAINFALL, PORTO RICO
(U. S. Weather Bureau)

(INCHES)

Section	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
North	82.87	86.15	74.60	68.17	67.79	62.15	64.20	78.44	57.69	75.88	60.55	54 41
West	78.80	77.66	77.28	80.78	66.79	70.79	80 84	88.56	72.44	76 61	93.85	82.27
East	78.78	95.44	77.82	61 50	82 95	75.21	72.87	65.48	63.20	90 98	74.71	61.18
South	45.81	70.44	45.02	49 82	58 27	57.07	44.81	40.10	36.18	56.58	44.86	42.80
General average	71.48	82.42	68.68	68.82	67 70	66 81	65 68	65.68	57.87	74.86	68.87	62 67

APPENDIX II

CANE HARVESTED IN VARIOUS PROPERTIES OF "RUSSELL & CO." AND GROUND AT GUANICA CENTRAL

Years 1917–1926

(Courtesy of F T Maxwell)

Year	Fortuna Division			Guánica Division			Pagán Division			San Germán Valley		
	Acres	Total Tons	Tons per acre	Acres	Total Tons	Tons per acre	Acres	Total Tons	Tons per acre	Acres	Total Tons	Tons per acre
1917	5,035.81	160,642.34	31.90	3,817 00	137,068.47	35.91	3,168.00	51,448.32	16.24	2,762.97	43,599.67	15.78
1918	4,962.69	144,712.04	29.16	3,764.25	110,681.31	29.39	2,885.95	36,481.33	12.61	2,681.65	31,348.49	11.69
1919	5,095.24	144,297.20	28.32	3,706.75	110,349.95	29.77	2,647.85	29.841.27	11.27	2,028 38	21,419.69	10.56
1920	4,660.13	98,981.16	21.24	3,451.00	84.791 07	24.57	2,264 40	28,350.29	12.52	2,009 96	31,073.96	15.46
1921	4,994 24	137,041.95	27.44	3,269.25	87,125.51	26.65	2,224.27	27,580.95	12.40	2,384.86	31,551.70	13.23
1922	4,908 61	114,665.13	23.46	3,385 25	70,616.32	20 86	2,050.55	31,373.42	15.30	1,971.87	19,876.45	10.08
1923	4,974 15	109,729.75	22.06	2,292 45	51,442.58	22.44	1,724.15	42,552 02	24.68	1,999.54	33,012.25	16.41
1924	5,265.11	137,366.72	26.09	1,644 50	38,431.97	23.37	2,773.69	82,766.91	29.84	2,242.13	54,954.61	24.51
1925	5,354.01	197,670.05	36.92	1,451 50	57.581 01	39.67	3,226.82	85,478.46	26.49	2,574.78	75,999.26	29.49
1926	5,485.85	194,889.63	35.32	1.558 25	60,884.08	39.04	3,192.67	85,306.14	26.72	2,619.01	62,122.92	23.73
Remarks	*Irrigated Area* No mosaic infection Mostly "Cristalina" from 1917 to 1923 B H 10 (12) and S C. 12 (4) the basis of 1925 and 1926 crops.			*Irrigated Area* Medium mosaic infection in 1920 and 1921. Heavy mosaic in 1922, but vigorous "rogueing" practiced. No disease from 1924 to date B H 10 (12) and S C 12 (4) the basis of 1925 and 1926 crops.			*Non-irrigated Area* Heavy mosaic starting in 1918 clear thru 1921. Uba began to be extended in 1922 and was the basis of last four crops.			*Non-irrigated Area* Heavy mosaic starting in 1918 clear thru 1922. Later changed to Uba.		

APPENDIX III

CENTRAL EUREKA, HORMIGUEROS, P. R.

(Courtesy of Mateo Fajardo)

Year	Varieties	Acreage	Tons Cane per acre	Tons Sugar per acre	Remarks
1920......	Cristalina and Rayada..	1,847 00	14 50	1 48	Mosaic starting
1921......	Cristalina and Rayada..	1,768.85	8 00	.77	Heavy mosaic
1922	Cristalina, Rayada and a little Uba	1,550 80	8 80	.81	Heavy mosaic
1923	60% Uba cane	1,790.50	14 16	1 38	Heavy mosaic
1924	95% Uba cane	1 885.87	20 22	1 86	Mosaic controlled by inmune Uba
1925	100% Uba Cane....... ...	2,178 00	19.85	1.72	Mosaic controlled by inmune Uba
1926 ...	Mostly Uba. .. Some B. H. 10 (12), S C. 12 (4) and P O J 36	1,951 30	21.00	1 78	Expect to extend slowly B. H. 10 (12) and S. C. 12 (4)

APPENDIX IV

SUGAR PRODUCTION OF PORTO RICO FOR THE YEARS 1916 TO 1917, SHOWING THE RELATION OF MOSAIC TO SUGAR CROPS

Mosaic Regions	Number of zones	Crops of 1916 and 1917	Crops in Tons (2,000 lbs.) and percentage compared with 1916 and 1917								
			1918	1919	1920	1921	1922	1923	1924	1925	1926
No. Mosaic	8	204,184.16 T. 100.0%	211,848.48 108.5	191,678.38 98.8	228,847.90 112.0	280,296.90 112.7	200,978.06 98.4	180,386.89 88.3	208,698.58 102.2	299,085.21 146.04	289,744.51 182.1
Slight Mosaic Infection	1	64,157.80 T. 100.0%	58.169,24 90 6	49,810.44 77.6	71,125.25 110.8	67.189.28 104.6	61,159.18 91.2	56,787.89 88.4	65,145.88 101.5	85,956.15 133.9	81,760.22 127.4
Medium Mosaic Infection	2	115,816.90 T. 100.0%	109,786.86 94.7	94,974.50 82 0	100,072.50 86.6	110,538.91 95.4	84,682 87 73 0	83,348.50 71.9	110,079.18 95.0	168,925.92 145.8	161,016.26 139.0
Heavy Mosaic Infection	4	87,082.12 T. 100.0%	64,687.23 74.2	53,782.95 61.7	67,256.76 77.2	68,885.58 78.4	46,005.40 52.8	47,087.50 54.1	53,684.88 61.6	84,284.28 96.7	78,044 67 89.6

NOTE: Appendix V is not published here.

Appendix VI

CENTRAL MERCEDITA, PONCE, P. R.

(Courtesy of J. H. Giles)

Year	Variety	No. of acres of each variety	Yield of sugar per acre	Remarks
1917	B 1355.	101.25	4.084	
	B 1030	113.25	4.065	
	Seedlings	.25	3.963	
	B 3289	.75	3.812	
	B 208	466.75	3.725	
	Cristalina	900.75	3.719	
	Otahite	1,085.75	3.398	
	B 6308	.25	No analysis	
	Total	2,669.90	3.619 Year Average	
1918	B 376..	1.25	3.733	
	Yellow Cal	14.75	3.188	
	D 109	25.50	3.175	
	B 208	1039.00	3.127	
	Java	22.50	3.154	
	Otahite	605.50	2.944	
	B. 6308	137.75	2.939	
	D 117 y 119	15.00	2.926	
	Cristalina	698.25	2.879	
	B 1030	154 25	2.825	
	B 6450	23.75	2 823	
	B 1355	76.75	2 684	
	B 1753	25.50	2 562	
	D 117	74.66	2.224	
	B 347	59.00	1.699	
	Total	2,902.75	2.965 Year Average	
1919	B 1753	59.75	3.219	
	B 6032	85.00	3.101	
	B 6308	109.75	3.096	
	B 1355	96.00	2.851	
	B 208	759.00	2.830	
	B 3412	3.00	2 721	
	Cristalina	902.00	2.679	
	D 117	184.98	2.632	
	D 109	44.25	2.438	
	Otahite	194.00	2.390	
	Java	317.50	2.381	
	B 6450.	48.25	2.395	
	B 1030	42.25	2.250	
	B 208 y Java Cristalina	19.00	4.516	
	B 6032	10.25	4.170	
	Cristalina y Otahite	40.50	4.060	
	B 208 y B 1355	13.00	4.020	
	B 208 y Cristalina	15.00	3.209	
	B 208 y B 6450	26.00	3.019	
	Cristalina y B 6450	15.00	2.899	
	B 208 y B 6308.	34.50	2.661	
	Cristalina y B 1355	33.50	2.566	
	Mixta	103.75	2.385	
	B 208 y D 117	5.50	2.294	
	Total	2,985.00	2.733 Year Average	

CENTRAL MERCEDITA, PONCE, P. R.—Continued

Year	Variety	No. of acres of each variety	Yield of sugar per acre	Remarks
1920	B. H. 10 (12)	3.09	6.176	
	B 4596	6.75	5.695	
	B 1355	16.25	4.781	
	P. R. 270	12.25	4.122	
	B 376	7.50	3.923	
	Java	226.75	3.878	
	B 6032	112.75	3.820	
	D 109	92.75	3.792	
	Otahite	87.25	3.664	
	B 208	1,320.00	3.632	
	B 6450	36.50	3 614	
	Cristalina	328 25	3.471	
	B 6308	39.75	3.305	
	B 1753	76.75	3.013	
	B 1030	29.25	2.970	
	B 7924	.50	2.770	
	B 208 y B 1809	22.00	6.016	
	Otahite, B 6450	10.75	5.194	
	Java y Cristalina	24.00	4.860	
	B 4596 y B 208	6.00	4.589	
	Java y B 6450	12.75	4 338	
	Otahite y B 208	26.00	4.161	
	B 6308 y B 208	3.50	3.998	
	Cristalina B 1355	16.00	4.042	
	Cristalina B 1753	20 00	3.925	
	D 109 y B 208	21.50	3.593	
	Cristalina y B 208	54.00	3.571	
	Otahite y B 347	2.00	3.130	
	Java y B 208	36.25	3.070	
	Mixta	116.74	2.995	
	B 6032 y B 208	1,381 55	2.679	
	Caledonia, D 109, Cristalina y B 3412	6 25	.852	
	Total	2,832.33	3.624 Year Average	
1921	Sta. Cruz 12 (4)	17.50	7.427	
	B. H. 10 (12)	47.25	6.801	
	Cristalina	787.25	4.258	
	B 7924	19.75	4.181	
	B 208	1,100.25	3 576	
	Otahite	34.50	3.364	
	D 109	47.75	3.166	
	B 6308	6.00	2.501	
	B 1753	8.50	2.290	
	Java	30.00	1.833	
	B 6450, 208 y B. H. 10 (12)	22.00	7.284	
	S. C. 12 (4) y B 208	13.50	5.899	
	B. H. 10 (12) y B 208	44.75	4.926	
	P. R. 270 y B 208	6.25	4.501	
	P. R. 270 y Mixta	12.00	4.456	
	Mixta	681.75	3.741	
	Otahite y B 208	36.25	3.448	
	Java y B 208	11.00	2.441	
	Cristalina, B 208	15.00	1.869	
	D 109 y B 208	21.50	1.302	
	Total	2,980.75	3.852 Year Average	

CENTRAL MERCEDITA, PONCE, P. R.—Continued

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1922	Java	9 00	5 781	
	Otahite, Cristalina y B 208	5 50	5 560	
	S. C. 12 (4).. .	16 75	5 177	
	B. H. 10 (12) Ba 6032	8 00	5 084	
	B H. 10 (12) .	82 75	4 699	
	B 208 y Cristalina	9 75	3 994	
	B 208	34 50	3 958	Year
	Ba 6032	14 75	3 702	of
	B H 10 (12) .	105 75	3 675	drought
	B 208	861 00	3 526	
	B. H 10 (12) y Mixta	17 75	3 491	
	D 109.	41 50	3 401	
	Mixta	1,444 84	3 340	
	B H. 10 (12), D 208 y B 6450	10 50	3 288	
	B. H. 10(12), B 208 y S C 12(4)	55 50	3 205	
	B 208, B 6450 y	158 25	3 853	
	Cristalina.	22 00	3 180	
	Java y B 208	19 00	2 699	
	B H 10 (12)	44 45	2 226	Non-irrigated area
	Ba 6032 y Mixta	13 00	1 857	
	P R 270 y B 208	6 25	1 385	
	Total	3 061 04	3 386 Year Average	
1923	Mixta y Ba 6032	12 50	6 338	
	D 208, B H 10 (12) y S C 12(4)	18 50	5 553	
	Ba 6032	7 50	4 844	Year
	P.R 270 y G C 347	3 50	4 476	of
	S C 12(4)	165 00	4 382	drought.
	B H 10(12)	514 50	3 809	
	Mixta y Otahite	10 00	3 491	
	B H 10(12) y S C 12(4)	36 50	3 279	
	B H 10(12) y B 208	92 75	3 309	
	Otahite	3 00	3 231	
	Ba 6032 y Mixta	170 50	2 954	
	B 208	414 25	2 823	
	Ba 6032 y Mixta	8 00	2 615	
	D 109.	4 00	2 452	
	P O.J. 105 y Japonesa	9 50	2 179	
	Japonesa	6 84	1 638	
	Mixta	1,584 75	2 778	
	Cristalina	8 00	1 031	
	Total	3,071 09	3 106 Year Average	

CENTRAL MERCEDITA, PONCE, P. R.—Continued

Year	Variety	No. of acre of each variety	Yield of sugar per acre	Remarks
1924	Ba 6032	3.50	5.631	
	S.C. Mixta	19.75	5.221	
	B.H. 10(12), S.C.12(4) y Mixta	40.00	5.058	
	B.H. 10(12) y Mixta	31.75	4.561	Year of drought.
	B.H. 10(12)	67.45	4.526	
	B.H. 10(12)	1,013.82	4.057	
	B.H. 10(12), Mixta, Japonesa y P.O J. 105	22 25	3.861	800 lbs. of fertilizer per acre.
	S.C. 12(4)	250.13	3 470	
	Patito	25 66	2.896	
	Mixta	1,576.94	2.819	
	Japonesa	13.55	2.444	
	Japonesa y Mixta	22 10	1.768	
	Abandonada	34.75	0.928	
	Total	3,121.79	3.358 Year Average	
1925	Mixta y B. H. 10 (12)	39 55	8.386	Rainfall this year was more abundant and better distributed. The period of growth was longer. Harvest of 1924 lasted until May 15, and that of 1925 lasted until July 9.
	P. O. J. y Mixta	13.50	8.101	
	B. H. 10 (12) y S. C	109.70	7 473	
	S. C. 12 (4)	371.90	6.583	
	B. H. 10 (12)	2,119.82	5.804	
	B. H. 10 (12) y Ba 6032	11.00	5.538	
	Mixta	485.07	5.205	
	Japonesa	67.95	4.447	
	P. O. J. 105	15.25	4.150	
	B. 208 y B. H. 10-12	6.75	3 881	
	Japonesa y Mixta	27.99	3.568	
	B. H. 10 (12) y S. C. 12 (4) y Mixta	9.65	3.281	
	Ba 11569	.75	1.841	
	Total	3,278.88	5.833 Year Average	
1926	Ba 11569 y 6032	7.80	7.718	There was less rainfall precipitation this year than the previous one.
	B H. 10 (12) y Japonesa	10.25	7.060	
	Ba 6032	17.25	6 865	
	Ba 11569	18.80	5.770	
	B. H. 10 (12), Japonesa, Mixta y S. C	11.00	5.678	
	G. C. 1237	2.60	5.290	800 lbs. of fertilizer used per acre.
	Japonesa y Java	7.50	5.112	
	B. H. 10 (12)	2,577.89	4 997	
	Ba 11569, B. H. 10 (12), y S. C. 12 (4)	35 40	4.893	
	S. C. 12 (4)	397 70	4.101	Cane harvested was three months younger.
	Japonesa	75.52	4.071	
	B. H. 10 (12) y S. C.	160.40	3.785	
	Mixta	69 20	3.381	
	B. H. 10 (12) y Ba 6032	11.00	2.517	
	Total	3,403.31	4.801 Year Average	

APPENDIX VII

CENTRALS OWNED BY THE AGUIRRE INTERESTS

(Courtesy of C. L. Carpenter)

Central "Aguirre", Salinas, P. R.

Year	Variety	No. of acres of each variety	Yield of sugar per acre	Remarks
1917	Cristalina and Others	8,775.00	3 47	Yield calculated on both administration and *colono* cane.
1918	Cristalina and Others	8,631.81	3.22	Yield of administration cane only.
1919	Cristalina and Others ...	8,571.73	3.39	Yield of administration cane only.
1920	Cristalina and Others ...	8,346.97	3 49	Yield of administration cane only.
1921	Cristalina and Others . .	8,071.70	3 47	Yield of administration cane only.
1922	Cristalina and Others	7,723.22	3 22	Yield of administration cane only.
1923	Cristalina and Others	7,838.69	2.79	Yield of administration cane only.
1924	Cristalina and Others	7,849.00	2.44	Yield of administration cane only.
1925	Cristalina and Others	8,270.79	4.10	
	B. H. 10 (12)...............	247.79	4.05	
	S. C. 12 (4)	33.29	4 75	
	Total	8,551.87	4.10 Year Average	
1926	Cristalina and Others	5,226.14	3.47	
	B. H. 10 (12)...............	2,336.90	5.71	
	S. C. 12 (4)	461.39	5.84	
	Total	8,024.43	4.23 Year Average	

CENTRALS OWDNED BY THE AGUIRRE INTERESTS—Continued

Central "Cortada", Santa Isabel, P. R.

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1920	Cristalina and Others	2,662.11	3.10	
1921	Cristalina and Others	2,696.78	2.99	
1922	Cristalina and Others.	2,620.17	2.48	
1923	Cristalina and Others.	2,343.80	1.98	
1924	Cristalina and Others.	2,179.01	2.45	
1925	Cristalina, Japonesa B. H. 10 (12) y S. C. 12 (4)	2,450.06	3.68	
1926	Cristalina.....	1,351.85	2.95	
	B. H. 10 (12)	544.37	4.93	
	S. C. 12 (4)	565.31	4.71	
	Total	2,461.53	3.79 Year Average	

Central "Machete", Guayama, P. R.

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1921	Cristalina......	2,556.00	3.21	
1922	Cristalina	2,321.00	3 61	
1923	Cristalina.	2,292.00	3 22	
1924	Cristalina	2,489.00	3 14	
1925	Cristalina......	2,452.49	4.27	A lot of B. H. and S. C. cane was used for seed.
	B. H. 10 (12)	63.98	4 21	
	S. C. 12 (4)	8.49	3 15	
	Total	2,524.96	4.27 Year Average	
1926	Cristalina and Others	1,420.25	3 55	
	B. H. 10 (12)..... .. .	715.85	5.55	
	S. C. 12 (4)	350.67	5.74	
	Total	2,486.77	4.48 Year Average	

Appendix VIII

FAJARDO SUGAR COMPANY, FAJARDO, P. R.

(Courtesy of J. Bird Arias)

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1916	D 109	46.21	3.93	
	D 109	20.50	2.97	
	B 6450	22.95	3.76	
	B 6450	.47	4.48	
	Yellow Caledonia	207.10	3.77	
	Yellow Caledonia	70.41	3.42	
	Sealy Seedling	33.35	4.08	
	Sealy Seedling	8.65	2.17	
	B 3412	8.88	4.80	
	B 3412	.46	2.74	
	B 376	23.01	3.93	
	B 376	8.59	4.15	
	D 448	6.25	1.61	
	B 208	1.55	2.42	
	B 208	16.08	3.00	
	G. C. 67	3.00	3.50	
	G. C. 67	.40	4.55	
	B 109	11.86	3.59	
	G. C. 759	7.89	2.24	
	G. C. 759	1.08	3.29	
	D 357	.04	2.	
	D 117	8.56	3 09	
	D 117	6.17	3.43	
	B 1355	7.81	2.42	
	B 1355	6.54	3.95	
	B 347	9.39	2.48	
	B 347	.42	97	
	B 3405	.29	2.41	
	W. Transparent	6.17	4.04	
	W. Transparent	.41	2.41	
	B 3289	10 57	2 95	
	B 1030	.54	3.23	
	D 116	.85	4 70	
	Cavangerie	.29	2.38	
	D 433	4.05	2.75	
	D 433	4 45	4.24	
	B 4596	8.52	3.77	
	D 1111	.18	2.92	
	G. C. 81	.44	4.77	
	G. C. 101	6.70	4.88	
	G. C. 698	1.10	4 78	
	G. C. 47	1.00	7.20	
	G. C. 54	2.68	4.47	
	G. C. 701	1.50	5.11	
	Mixed	8,337.18	2 481	
	Total	8,924.54	2.50 Year Average	
1917	Mixed 90% Others 10%	9,277.66	1.61	Yield of various varieties not calculated

FAJARDO SUGAR COMPANY, FAJARDO, P. R.—Continued

Year	Variety	No. of acres of each variety	Yield of sugar per acre	Remarks
1918	B 3578	.95	4.34	
	B 6388	.55	4.64	
	B 3412	10.42	3.24	
	B 208	2.99	5.57	
	White Transparent	8.87	5.31	
	B 3405	11.89	3.08	
	Caledonia Amarilla	270.42	2.95	
	Sealy Seedling	30.30	2.99	
	D 433	8.84	2.62	
	D 448	14.14	3.09	
	G. C. 101	9.07	3.26	
	B 1355	9.87	2.70	
	B 109	12.77	2.84	
	D 109	70.64	2.57	
	B 4596	20.38	2.61	
	B 3289	4.38	2.04	
	B 376	119.92	2.18	
	B 347	10.04	2.12	
	B 6450	59.95	1.80	
	Mixed, Cristalina	79.63	1.92	
	D 117	35.61	1.68	
	D 116	.85	1.87	
	B 3922	18.56	1.75	
	Mixed	6,882.58	2.287	
	Total	7,693.62	2.323 Year Average	
1919	G. C. 47	2.38	5.12	
	D 433	17.72	3.71	
	B 6450	2.21	3.24	
	G. C. 67	.72	3.15	
	G. C. 101	55	3.13	
	G. C. 101	12.50	2.68	
	D 117	86.19	2.66	
	Yellow Caledonia	489.45	2.50	
	B 347	5 54	2 50	
	White Transparent	3.77	2.38	
	B 4596	13.75	2.39	
	D 109	265 42	2.36	
	Otahiti	1.07	2 36	
	D 448	24.50	2.35	
	B 1355	4.08	2.23	
	B 3412	22.33	2.21	
	B 3405	19.74	2.15	
	B 109	12.92	2.12	
	B 208	6.31	1.98	
	Sealy Seedling	321.76	1.90	
	Cristalina	60.48	1.82	
	B 376	66.37	1.77	
	B 3922	7.84	1.62	
	D 110	2.82	1.30	
	Mixed	7,473.89	1 969	
	Total	8,924.31	2.020 Year Average	

FAJARDO SUGAR COMPANY, FAJARDO, P. R.—Continued

Year	Variety	No. of acres of each variety	Yield of sugar per acre	Remarks
1920	D 433	222.20	4.07	
	Cavangerie	.25	3.87	
	B 3412	31.99	3 62	
	G C 101	5.88	3.33	
	D 116	2.82	3.20	
	Otahite	1.66	2.85	
	B 3405	13.79	2.80	
	W. Transparent	1.87	2.75	
	Yellow Caledonia	417.82	2.73	
	B 6450	26.88	2.69	
	B 4596	8.40	2.68	
	Sealy Seedling	270.80	2.64	
	D 117	58.20	2.63	
	B 1355	4.08	2.44	
	B 109	10 29	2.32	
	D 109	276.28	2.14	
	D 448	18.84	1.99	
	B 347	4.39	1.90	
	B 376	37.59	1 77	
	B 208	6.32	1.55	
	Mixed	8,868.55	2.463	
	Total	10,288.90	2.317 Year Average	
1921	D 433	453 35	2.72	
	B 3412	30.69	2.79	
	Yellow Caledonia	455.42	2.18	
	Otahite	1.07	2.18	
	D 117	45.35	2.15	
	B 1355	4 08	2.54	
	D 448	12.85	1.75	
	D 109	174.36	1.61	
	B 3405	15 45	1 61	
	G C 101	4.88	1.95	
	B 109	10.42	1.82	
	B 4596	8 40	1 69	
	B 347	4.39	1.72	
	Sealy Seedling	208.79	1 40	
	White Transparent	1.87	1.26	
	B 6450	38.88	1.62	
	B 376	26.09	1.21	
	Mixed	8,105.42	1.855	
	Total	9,601.76	1.875 Year Average	
1922	D 433	1,517.81	3.51	
	D 109	248.19	2.56	
	B 3412	30 34	2.71	
	B 3405	3 80	2 14	
	Yellow Caledonia	322 71	2 18	
	B 1355	4 08	1 89	
	D 117	41.79	2 03	
	B 6450	20.12	1.98	
	B 347	4.48	1.90	
	Sealy Seedling	89.96	1 79	
	B 109	10 15	1.20	
	Mixed	6,326.02	2.16	
	Total	8,515.02	2.16 Year Average	

FAJARDO SUGAR COMPANY, FAJARDO, P. R.—Continued

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1923	D 433	2,495 06	2 97	
	Yellow Caledonia	181 81	2 13	
	D 109	225 30	1 87	
	B 3405	9 30	1 75	
	B 3412	14 71	1 77	
	Seely Seedling	16 69	1 65	
	F C 137	10 28	4 97	
	F C 306	24 88	4 22	
	F C 214	6 94	4 06	
	F C 262	6 40	3 65	
	F C 299	13 85	3 79	
	F C 90	12 87	2 84	
	F C 199	18 83	3 06	
	F C 148	40 38	2 77	
	F C 101	19 26	2 71	
	F C 88	10 87	2 68	
	F C 86	11 02	2 08	
	Mixed	4,654 84	2 02	
	Total	7,773 29	2 355 Year Average	
1924	F C 306	71 76	4 31	
	Striped Caledonia	5 61	3 79	
	S C 12 (4)	3 57	4 10	
	F C 214	20 04	3 83	
	F C 299	137 06	3 59	
	B H 10 (12)	4 63	3 78	
	F C 137	15 23	3 59	
	D 433	4,095 90	3 85	
	F C 199	68 82	3 28	
	F C 140	26 05	2 86	
	Yellow Caledonia	111 52	2 10	
	D 109	101 58	1 98	
	B 3405	3 80	1 38	
	Mixed	3,379 59	2 42	
	Total	8,045 16	2 889 Year Average	
1925	F C 306	317 58	4 45	
	Striped Caledonia	14 20	3 73	
	B H 10 (12)	5 46	5 10	
	F C 137	24 09	3 64	
	D 433	5,481 06	3 68	
	S C 12 (4)	1 50	4 61	
	F C 214	44 70	3 58	
	F C 299	142 80	3 05	
	Yellow Caledonia	124 66	2 51	
	F C 140	84 98	2 71	
	F C 199	72 91	2 78	
	D 109	24 02	2 16	
	Mixed	2,287 46	2 42	
	Total	8,452 76	3 345 Year Average	

FAJARDO SUGAR COMPANY, FAJARDO, P. R.—Continued

Year	Variety	No of acres of each variety	Yield of sugar per acre	Remarks
1926	B. H. 10 (12)	117 09	4.95	
	S. C. 12 (4)	14.98	4 36	
	Striped Caledonia	25.73	3.80	
	F C 306	703 59	3.75	
	F C 187	22.76	3.02	
	D 433	5,702.40	3.00	
	F C 140	43.99	3.08	
	F C 214	67.14	2.99	
	F C 199	102.00	2 99	
	F C 299	175.63	2 63	
	Yellow Caledonia	35.87	2.33	
	Mixed	1,293.53	2.836	
	Total	8,304.71	3.059 Year Average	

A MONOGRAPH OF SUGAR-CANE VARIETIES

By Arthur H. Rosenfeld
Special Technologist for Cane, Insular Experiment Station of Porto Rico

In this Journal, Vol. III, No. 2, under date of April, 1919, there appeared a preliminary paper by Mr. F. S. Earle on "Sugar-Cane Varieties of Porto Rico". This excellent study was followed by that masterpiece in cane varietal studies, "Sugar-Cane Varieties of Porto Rico—II" by the same author, as Vol. V, No. 3 of the Journal, under date of July 1921, which presented the results obtained by Mr. Earle up to that date in the continued study of this vitally important subject. Additional data was therein given concerning varieties discussed in the previous paper, as well as a considerable number not touched upon in the first studies. In this latter monumental work Mr. Earle made such an excellent preliminary statement and so well outlined the history of cane varieties in Porto Rico that it has been decided by the present author to use that part of Mr. Earle's paper in its entirety in this, adding only a few illustrations to bring out more clearly some points in the descriptions.

In Vol. IV, No. 3, under date of July, 1920, Mr. Earle published a very useful work entitled "An Annotated List of Sugar-Cane Varieties", which contained a remarkably complete alphabetical index of all of the names applied to sugar-cane varieties in different parts of the world as far as they could be found in the literature accessible to him, this having been found necessary by Mr. Earle in his attempts to trace the history of the older varieties found in Porto Rico, due to the enormous confusion existing in the use of varietal names in cane literature. This study, as Mr. Earle pointed out, with the synonomy which it was possible to trace with more or less certainty, served to clear up a number of points which had hitherto been most obscure.

The present paper is an attempt to summarize the results obtained by the author in following up Mr. Earle's pioneer work on varieties of sugar cane and he has attempted to maintain the same form of description and the identical treatment given to the subject by Mr Earle in his previous and most valuable papers. It was the writer's first intention to call this paper "Sugar-Cane Varieties of Porto

Rico—III" and include therein only those varieties which he has studied in addition to those already touched upon by Mr. Earle, but, due to the facts that Mr. Earle's "Sugar-Cane Varieties of Porto Rico—II" has been for some time completely exhausted and that the economic status of a number of varieties—notably B.H.-10(12) and S.C.-12/4 has changed so materially in the past five years in Porto Rico, it was decided to make the present paper include not only the varieties studied since Mr. Earle's departure from the Station, but all of those described by him in his earlier papers. Hence, the present paper is a compendium of all of the varieties of cane described in Porto Rico to date, those described by Mr. Earle being indicated in the text by an asterisk.

Inasmuch as this whole work is based on work originated and carried out by Mr. Earle, the author would have preferred to have brought it out jointly with him, but it was finally decided that, inasmuch as Mr. Earle has not had the opportunity of seeing the larger number of varieties herein described under Porto Rico conditions, the writer could hardly make him jointly responsible for the possible—and probable—errors in the technical descriptions included in this work, nor for what might turn out to be misconceptions of the economic value of this or that variety under determined conditions. He does wish to make it very clear, however, that he makes no claim for originality in bringing out the present paper and to repeat that herein he has simply endeavored to bring up to date the work so ably initiated by Mr. Earle. To the man who planned and originated these labors should go all the credit for whatever the present studies may be worth—the author wishes to emphasize the fact that Mr. Earle was the pioneer in these investigations and that it has been a comparatively easy matter for him to follow a trail so clearly blazed, particularly as he has been able to get together a much larger and more representative collection than that which Mr. Earle had available.

The writer wishes to acknowledge, also, the great assistance rendered him by Mr. Luis Serrano, the Assistant Agronomist at the Station, who has participated with him in all descriptions of varieties made and whose keen sense of values and fine perception of important minute structural differences have been of great utility in making these descriptions more accurate and exact. Mr. Serrano's willingness to "be on the job" at any time has aided materially in bringing this work to an earlier conclusion than would have otherwise been possible.

Another debt of gratitude which the author wishes to acknowledge is that to Mr. W. C. Dreier, Manager of the Hatillo Fruit Farm. Interested in cane varieties by the contagious enthusiasm of Mr. Earle, Mr. Dreier obtained from him when Mr. Earle left the Station quite a complete lot of the varieties at that time growing there and he has cared for, experimented with and made the most careful notes on these and other varieties which he has added to the collection from time to time, in a practical as well as scientific manner which it would have been well nigh impossible for us to have attained with our limited extension of land and unlimited other duties at the Station. Experimentation from the point of view of the strictly practical cane planter, who is making a logical effort to obtain just the varieties which will give him the largest financial return under each of his distinct sets of conditions, is of exceptional value in cane varietal work and close association with Mr. Dreier in the management of his varieties for the past three years has enabled the author to obtain a point of view on the commercial side of the question far broader, he feels sure, than would have been possible without this whole-hearted cooperation from Mr. Dreier.

To Mr. Mario Brau de Zuzuarregui, who has so carefully and painstakingly prepared the colored illustrations which accompany this report, and who has at all times been so amenable to suggestions by the writer, acknowledgment is also due.

And last, but by no means least, the writer wishes to acknowledge the many suggestions and exceptional cooperation which he has received while preparing this work for the past three years from Commissioner of Agriculture Carlos E. Chardón and the Director of the Insular Station, Mr. Fco. López Domínguez. Without the constant aid received from both of these gentlemen, this report would still be far from conclusion.

GENERAL REMARKS

By F. S. Earle

The selection of the proper variety for each local planting is the one most important factor in sugar-cane production. Its importance is strangely overlooked by the average planter, who only too often plants his one favorite kind in all kinds of soils and under all kinds of circumstances with no thought of its adaptability; or, as often happens in Porto Rico, he plants a miscellaneous mixture of kinds in the same field. Neither plan will give really satisfactory results. In the present state of the sugar market (January 1921) the most painstaking care is necessary at all points in order to secure a reasonable profit. Each variety is particularly adapted to certain soils and certain conditions and will only give its best results when these requirements are complied with. It is, however, in connection with insect pests and diseases that the question of variety becomes most important. Some are susceptible to each of these plagues while others are more or less resistant or even immune. In every important cane-growing country in the world the industry has been seriously threatened at one time or another by the sudden appearance of some one of these plagues. In each case, after heavy losses and much effort, the situation has been saved by the substitution of more resistant kinds for the ones previously in general cultivation. Aside from strictly preventive measures no practical remedy is known for any sugar-cane diseases except that of substituting some more resistant kind. As this fact came to be realized it lead to the searching of all sugar-growing countries for desirable kinds and the establishment of large living collections, first in Mauritius, then in Java and later in Australia, Brazil, Jamaica, Louisiana, Hawaii and various other countries. Then came the discovery that sugar cane produced fertile seed and with it the making of new seedling kinds. For the past twenty years this has so absorbed the attention of sugar-cane investigators that the older varieties have been forgotten long before most of them had been properly tested and their adaptability determined. This is unfortunate. The very fact that those are kinds that had merit enough to survive for generations under the crude agricultural practices of the country of their origin demonstrates their usefulness. When first brought to a new country and planted in trial grounds they have often, perhaps, found uncongenial sorroundings and so have

made a poor showing and been discarded, when under slightly different conditions they would have succeeded admirably. Thus the Uba cane when first brought from Brazil to Mauritius in 1869 was noted as "worthless", but it has since saved the industry in Natal, where it is the only cane planted and (under the name of Kavangire), it has been of the greatest assistance in freeing Western Porto Rico from the mosaic disease, to which it proves to be almost absolutely immune. It is not intended to belittle the importance of the work of producing and testing new seedling varieties. It has already done much for the sugar industry in many parts of the world and will unquestionably do much more in the future. It is only wished to call attention to the importance of continuing to test the older kinds until their adaptability is fully determined for all conditions and for all purposes.

In the first paper on sugar-cane varieties of Porto Rico the subject-matter was divided under two distinct headings, the one dealing with the cultural characteristics and value of the different varieties and the other giving an attempted technical description, thus treating of them taxonomically or botanically. This method has certain obvious advantages, but it was disregarded in the second paper, where all the available data regarding each variety was grouped under the one heading, an arrangement which it is believed is on the whole more convenient for reference.

THE DEMONSTRATIONS OF VARIETIES

In a previous paragraph attention has been called to the unfortunate premature abandonment of the testing and study of many of the older cane varieties and the centering of attention on the production of new seedlings. This has naturally followed from the prevailing belief that existing varieties quickly and inherently deteriorate and run out. This idea is everywhere found in the literature and the view is widely held that this is why a change of variety has become necessary in so many sugar-producing countries. This idea is not confined to sugar-cane varieties. It has been widely accepted as a fact that cultivated varieties of plants of all kinds that are continuously propagated asexually have, like individual animals, their definite period of life—that they flourish for a certain length of time, each according to its special nature, then degenerate and finally disappear from cultivation or die. Horticultural writers in particular seem to be firm in this belief. Innumerable instances of it could be cited, particularly in the literature of potato and strawberry varieties. Curiously enough, this belief has been considered

as axiomatic and no facts have been brought forward in proof of it that could not more easily be explained on some other basis. The fact seems to be that most of the so-called cases of deterioration or degeneration have been caused either by climatic changes, soil exhaustion or the increase in insect pests and disease to which the variety in question was susceptible, and not by any change in the nature of the variety itself. Often, too, varieties have been abandoned because of the introduction of better and more profitable ones. Most cultivated varieties have been selected on account of their adaptability to some special local need. As a rule they are only adapted to a narrow range of cultural conditions, and when these change or when they are taken to a different environment they suffer. Occasionally a variety is found adapted to a wide range of conditions and these remain long in cultivation, extend over great areas, and become recognized as the standard varieties of their kind. Such kinds show no signs of degeneration unless confronted with radically changed conditions of growth. Ben Davis apples, Bartlett pears, Elberta peaches, Concord grapes, and Navel and Valencia oranges are growing today on countless thousands of acres with the widest possible geographical distribution and with no sign whatever of deterioration. Under favorable cultural conditions they show the same vigor and productiveness that they did many years ago at the time of their first introduction. Cultivated varieties of plants may degenerate; it would be difficult to prove the contrary, but the fact remains that no evidence has been brought forward to show that they actually are degenerating except through the action of purely external causes. On the other hand, much evidence could be cited to show that they may be constantly improved by the continued selection of bud variations. This is a phase of the question, the great importance of which seems to have only been appreciated by a very few investigators. Shammel's work with citrus varieties in California may be cited as one of the few instances in point.[1]

To return to sugar cane: The Caña Blanca or Otaheite is the one usually cited as a case of deterioration. Scarcely an article on cane varieties has been written during the last fifty years that does not assume the degeneration of the Otaheite as an accepted fact. It is unfortunately true that it has been found necessary to abandon the cultivation of this once popular variety in one after another of most

[1] Shamel's bud selection works on sugar cane in Hawaii, however, have not been so strikingly successful.—A. H. R.

all the sugar-producing countries.[1] This forced change of varieties has only too often been accompanied by heavy financial losses and sometimes by the threatened ruin of the sugar industry. This does not prove, however, that the Otaheite had degenerated. Its nature today seems much the same as it was a century and a quarter ago, when it so dramatically replaced the old Caña Criolla that was then universally cultivated. As always, is is a cane adapted to a narrow range of cultural conditions. It requires a well-aerated soil abundantly supplied with vegetable matter. These conditions are admirably supplied by virgin-forest lands. It was on such lands that Otaheite was first planted in the West Indies and on such lands it gained its great reputation. When it became necessary to plant cane on old compact lands where the humus and other elements of fertility were partially exhausted, then the Otaheite failed, and failed miserably. Its root system is not adapted to these conditions and it is unduly susceptible to most cane diseases. Planted today on virgin lands it grows with its old-time vigor. It is *conditions* that have changed. The soil has deteriorated, but not the Otaheite cane. It is only a striking example of the necessity of selecting varieties adapted to the particular soil conditions under which they are to grow.

The Cristalina may be taken as another example to show that deterioration is not an inherent characteristic of cane varieties. In so far as we can trace its history this is as old a cane as the Otaheite. Coming originally from Java it has been carried to all sugar-cane growing countries. It seems to have been brought to the West Indies at about the same time as the Otaheite and to have had about the same distribution. It was not a favorite with the early planters since it did not mill quite as easily as the Otaheite and its juices were harder to handle under the old open-kettle methods. It was, however, so much hardier and was adaptable to so much wider a range of conditions that in one country after another it has quite completely driven out and replaced the Otaheite, notwithstanding the prejudices of the older planters, and is today under one name or another considered as the standard cane in many of the largest sugar-producing countries. This cane is adapted to a much wider range of soil conditions than the Otaheite and is more resistant to most insects and diseases. It is easily our one best general-purpose

[1] Peru is the notable exception to this rule.—A. H. R.

cane. That it is not degenerating may be proven by its continued good behavior in thousands of fields and in many countries, in fact, wherever reasonably good cultural conditions are still found. The recorded yield of an average of 81 tons per acre on a 40-acre field of the irrigated lands at Aguirre some years ago gives testimony to its continued vigor and productiveness. Although so much more hardy and resistant than Otaheite, it is however, failing in many localities from the same causes; mainly from root disease induced by unduly compacted and exhausted soils and the failure to give rational tillage. It is being replaced by other kinds, not because it has deteriorated but because other kinds have been found that are still more resistant, or that are better adapted to the changed soil conditions.

THE POSSIBILITY OF IMPROVING EXISTING VARIETIES THROUGH THE SELECTION OF BUD VARIATIONS

The belief expressed in the previous paragraphs that varieties are not inherently deteriorating does not imply that they are necessarily fixed and immutable. In fact, the contrary is known to be the case. Change is the universal law of living beings. Within limits like produces like, but this inheritance is not absolute. It is true, also, that plants propagated asexually from buds resemble the parent form much more closely than those propagated from true seeds, but no two buds even from the same shoot will produce plants that are absolutely identical. Sporting, a sudden and pronounced form of bud variation, is known to occur with many plants. It seems to be particularly prevalent in the tropics. Several striking cases of it among different ornamental plants have fallen under the writer's observation in Cuba. It is known to have been the origin of many well-marked horticultural varieties. The not infrequent occurrence of striking color variants in sugar cane is a well-known fact and the case of the three differently colored forms of the Cheribon cane, Rayada, and Cristalina and Morada, has been often cited. An exactly similar case occurs with the Tanna canes, Yellow Caledonia, Black Tanna and Big Ribbon or Striped Tanna being color variants of the same stock. Otaheite has produced two differently colored striped bud sports, one yellow and green and one yellow and red, and the latter has sported again to produce a solid colored red cane. Here we have four distinct color forms from the one stock. At least four striking instances of striped sports appearing in cultures of self-colored canes have been observed by the writer in Porto Rico. In

three of the cases the striped sports were planted and the resulting progeny has uniformly been striped. The fact that canes are known to produce such striking differently colored bud sports at once suggests the question as to whether or not they are not also sporting in other directions which perhaps may have more practical importance though less easily detected by the eye. Are there not "sports" having a greater or a lesser sugar content than the normal? or do not some individuals have greater vigor and greater resistance to certain diseases than the others? There are many indications that this may be the case; and the inherent probabilities all favor the idea of such variations, or of such mutations if it is preferred to so consider them. The idea of a possible inheritable variation in sugar content has occurred to many investigators and there have been numerous attempts at experimental proof. Such work has been done by Edson and Stubbs in Louisiana, d'Alburquerque in Barbados, Watts and various other workers in the other British West Indies, Rosenfeld in Argentina, Greimly in Australia and particularly by Kobus in Java. Various methods have been followed, mostly based on the idea of the chemical selection of the stalks richest in sugar. In some cases the attempt has been made to find and isolate unusually rich strains from which to propagate, but Kobus' method looked toward the general improvement of the variety by mass selection based on the use of those seed pieces showing the greatest specific gravity, this usually being an indication of high sugar content. He seemed to get very favorable results, but later workers in Java consider his methods impractical. In fact, no really practical results have come from any of these efforts. One of the greatest difficulties in this line of work is the fact that sugar content is dependent not only on the inherited characteristic of the cane, but to a much greater degree on soil and weather conditions with their influence on the maturity of the plant. Age is another important factor. Different stalks in the same stool when of different age and maturity differ widely in sugar contents, as do the different joints in the same stalk. This makes any form of chemical selection a difficult problem, but it by no means proves it to be insoluble. The question is worth further careful and continued effort.

The other phase of the problem of selection within the variety, that of trying to find and propagate strains or variants that show greater vegetative vigor and more resistance to specific diseases, has been strangely neglected, the only reference found being an account

of an attempt in Java to find strains of Black Cheribon that would resist Sereh. This line of work would be much easier to carry out than the other since such valuable strains, if they do exist, may be detected by the eye by a careful inspection in the fields exposed to the unfavorable conditions which it is desired to combat, whether, this is soil exhaustion, root disease, gum disease, mosaic or any other specific trouble. It is a matter of common knowledge and observation that in such exposed fields there are always certain stools that seem to be thriving better than their neighbors. In most cases this simply means a better local soil condition, but the possibility always presents itself that some of these better stools may represent inherently different strains. This can only be proven by taking seed cuttings from these promising stools and planting them side by side where they will be exposed to the same unfavorable conditions. As a case in point, on the older cane lands of Cuba where the practice of long ratooning prevails and where little attention is given to replanting the vacancies in old fields, areas are frequently found where the cane has died out from root disease. These open areas, or *sabanas* as they are locally called, often reach an area of an acre or more before the field is abandoned and plowed up.

Almost always, however in the midst of these open grassy places will be found an occasional stool of cane growing vigorously, notwithstanding absolute neglect, and often living on for years after all it neighbors have died from root disease. The conclusion is irresistibl that some, at least, of these stools represent cases of real immunity. So many such cases came under the observation of the writer some years ago while acting as consulting agriculturalist for the Cuban American Sugar Company, and the chances seemed so good for practical results from the selection and propagation of these possibly resistant strains that the appointment was secured of H. B. Cowgill, a graduate in plant-breeding, and he was set to work searching for and propagating all promising material of this kind. At the end of six months several hundred selections had been secured and planted in a nursery for further testing and propagation. A complete change in the policy of the company, however, caused the work to be suddenly abandoned, so that no results whatever were obtained.

Another example of the possibilities in this line of selection is afforded in the cane fields of western Porto Rico that have been so completely invaded by the mosaic disease. There are some fields that are absolutely a hundred per cent infected. In the great majority

of even the worst cases, however, here and there a stalk will be seen that is still healthy. These stand up well above their infected neighbors and are quite conspicuous from their darker green color. Of course such cases are largely accidental; however the possibility exists that some of them may represent real resistance or even immunity. A strain of Rayada or Cristalina having real resistance to this disease would have such great practical value as to amply repay the effort of searching for it. A few of these striking cases have been brought in and are now growing on the Station grounds.[1] The danger, however, of bringing in incipient cases of mosaic disease has been too great to do this work of selection on a large scale here where it is necessary to keep the grounds free from mosaic. The planting of a cooperative immunity experiment on the grounds of the College of Agriculture at Mayagüez seemed to offer an opportunity for this work. Some fifty or sixty healthy canes were therefore selected from heavily diseased fields in the Añasco valley and were brought and planted with this experiment. Continued drouth led to the complete failure of this planting and again the attempt at asexual selection for disease resistance has given no results. This attractive field still remains open for future investigators.

THE FLOWERING OF SUGAR CANE

Some varieties of sugar cane flower or "arrow" freely, the fields in the late fall with their waving pampa-like plumes being much more striking than a corn field in tassel. Other kinds seldom or never flower, at least under Porto Rican conditions. Some of the older writers attempted to use this distinction as the basis of a classification dividing cane varieties into two groups, one containing the canes that do not arrow. This grouping is of little practical use, however, since there are many kinds, including such standard widely planted varieties as Cristalina and Rayada, which bloom freely in some years and on certain soils while under other conditions and in other years they completely fail to bloom. Thus in Cuba where Cristalina is grown so extensively it very seldom blooms on the red lands while on the black lands it frequently blooms very freely. Just what the conditions are which induce or inhibit blooming is not well understood. The arrows usually appear in November and December. In Cuba this coincides with the beginning of the dry

[1] None of these proved particularly resistant to Mosaic eventually.—A. H. B.

season and the opinion prevails that it is induced by the sudden checking of growth due to the lack of moisture. In Porto Rico, howewer, cane blooms at about the same season, though November and December, at least on the north coast, are usually wet months. The age of the cane is, of course, a factor of importance. As a rule, arrowing does not occur when the cane is less than twelve months old.[1] Spring-planted cane, therefore, arrows much less than fall-planted or *gran cultura* cane. There are some varieties, however, that will arrow with the coming of November even if planted as late as May or June. With the craze of new seedling varieties that has dominated the sugar-cane world during the last twenty years the question of arrowing has taken on new importance since only those canes which flower freely could be used as parents for new varieties. All of these newer kinds are thus descended from free flowering kinds and it is natural that most of them tend to arrow more freely than is usual with the older varieties which have been propagated asexually for a great number of years. It seems necessary, therefore, to note somewhat carefully the tendency to arrow in each of the varieties under study and to determine the effect of arrowing on sugar production and on the general usefulness of the variety. Arrowing, of course, stops the further growth in length of the cane and thus tends to limit tonnage. As it is a sign of maturity is is popularly supposed that arrowing indicates the time of greatest richness in sugar cane and that if left in the field after arrowing it will soon begin to deteriorate and go off in sugar content. As a rule, however, arrowed cane does not die. The arrow breaks off and three or four of the upper buds grow out into new shoots and the old stalk may remain in usable condition for weeks or months. The Insular Station has done considerable chemical work to try and determine just what effect on the sugar content of the juice is produced by the flowering and the subsequent sprouting and growth of the axilary buds. Duplicate samples have been taken at different stages from a number of varieties that showed both arrowed and non-arrowed stalks in the same row. The results of these analyses are given in the following table:

[1] This rule does not apply to the Chinese canes in general.—A. H. R.

Variety	Date	Age	Arrow	Extr	Brix	Suc	R S	Puri	Fiber
D 109	12 30 20	Rat 9 mo	No	70 0	18 94	16 88	0 91	85 58	10 80
D 109	12 30 20	Rat 9 mo	Yes	67 3	20 04	17 85	1 15	89 70	13 08
D 109	2 4 21	Pl 16 mo	No	65 2	18 00	16 33	0 59	90 72	11 18
D 109	2 4 21	Pl 16 mo	Yes	64 0	17 50	15 34	0 62	87 65	12 24
D 109	4 6 21	Pl 17 mo	No	68 7	16 80	13 59	1 26	83 37	12 52
D 109	4 6 21	Pl 17 mo	Yes	67 8	19 00	17 09	0 61	89 47	12 85
D 117	12 30 20	Rat 9 mo	No	69 12	15 18	12 15	1 69	80 40	11 58
D 117	12 30 20	Rat 9 mo	Yes	67 2	16 53	13 66	1 71	82 52	11 80
D 117	12 20 20	Rat 14 mo	No	67 6	16 30	13 78	0 72	84 54	10 86
D 117	12 20 20	Rat 14 mo	Yes	68 7	17 20	15 03	0 21	87 38	10 60
D 117	2 2 21	Rat 16 mo	No	75 0	15 15	12 40	1 36	81 84	11 00
D 117	2 2 21	Rat 16 mo	Yes	67 0	18 30	15 82	0 76	86 44	11 22
D 117	2 4 21	Pl 16 mo	No	64 7	17 20	14 71	1 50	85 52	12 60
D 117	2 4 21	Pl 16 mo	Yes	61 5	17 50	15 20	1 18	86 55	12 82
D 117	4 6 21	Pl 17 mo	No	69 2	19 00	17 20	0 77	80 52	12 82
D 117	4 6 21	Pl 17 mo	Yes	68 0	19 45	18 02	0 61	82 64	12 80
Uba	2 7 21	Pl 16 mo	No	68 8	15 50	13 16	0 95	84 80	13 08
Uba	2 7 21	Pl 16 mo	Yes	61 1	17 80	15 83	0 40	88 93	14 00
Uba	2 28 21	Rat 16 mo	No	68 5	17 50	15 93	0 39	90 83	13 86
Uba	2 28 21	Rat 16 mo	Yes	64 1	17 90	16 26	0 48	90 83	14 86
Uba	4 4 21	Pl 17 mo	No	61 8	18 90	16 53	1 06	84 86	12 67
Uba	4 4 21	Pl 17 mo	Yes	63 5	18 40	15 89	1 01	86 35	13 00
P R 260	12 22 20	Rat 14 mo	No	70 8	14 33	10 67	2 08	74 04	9 84
P R 260	12 22 20	Rat 14 mo	Yes	65 8	16 80	14 00	1 01	83 33	13 08
P R 260	1 28 21	Rat 15 mo	No	69 [illegible]	15 40	12 4[illegible]	1 47	80 81	12 44
P R 260	1 28 21	Rat 15 mo	Yes	65 0	17 00	14 81	0 [illegible]	87 11	14 00
P R 260	2 28 21	Pl 17 mo	No	64 2	17 85	15 90	0 62	89 0	12 88
P R 260	2 28 21	Pl 17 mo	Yes	65 1	17 95	15 79	0 7[illegible]	87 47	13 96
P R 260	3 30 21	Rat 14 mo	No	70 8	18 00	15 97	0 55	88 72	12 84
P R 260	3 30 21	Rat 14 mo	Yes	70 2	18 05	16 09	0 30	89 14	11 92
P R 292	12 30 20	Rat 15 mo	No	70 0	15 73	13 80	0 87	8[illegible] 59	10 80
P R 292	12 30 20	Rat 15 mo	Yes	68	1[illegible] 53	15 59	0 65	88 93	12 60
P R 292	12 7 21	Pl 16 mo	No	66 6	16 50	16 80	0 65	90 81	12 02
P R 292	12 7 21	Pl 16 mo	Yes	61 9	18 20	16 47	0 56	[illegible] 38	1[illegible] 95
P R 292	12 28 21	Pl 17 mo	No	69 4	19 60	18 11	0 41	92 39	12 24
P R 292	12 28 21	Pl 17 mo	Yes	67 9	19 25	17 28	0 49	89 [illegible]6	12 84
P R 292	3 3 21	Rat 14 mo	No	70 5	1[illegible] 5	16 05	0 39	90 42	12 98
P R 292	3 30 21	Rat 14 mo	Yes	71 4	18 50	16 80	0 33	90 81	11 11
Average above 19 lots non arrowed				68 83	1[illegible] 06	14 8	[illegible]	86 15	11 95
Average above 19 lots arrowed				66 11	18 0	15 05	0 65	88 19	12 65

These figures show that taking the average for the season, the arrowed cane gives about 1 per cent more sucrose and 2 per cent better purity than the non-arrowed and that the percentage of reducing sugars is appreciably less On the other hand, fiber averages a little higher and extraction, at least by the small laboratory mill, is about 2 per cent less An inspection of the detailed figures shows that these differences are more marked early in the season than they are later when the cane reaches better maturity Close watch has been kept to detect the point at which the supposed deterioration of the arrowed cane should begin No evidence has been found to show that such deterioration is a necessary or even an usual effect of arrowing. Arrowing is, of course, an indication of maturity Fully matured cane has less vegetative vigor with which to resist the entrance of *Melanconium* and other rot organism, and the breaking off of the arrow affords and easy opening for their entrance It is doubtless true that a larger proportion of arrowed than of non-arrowed cane is lost from rot when the cane stands too long in the

field, and it is this that has doubtless led to the idea that arrowing is followed by deterioration.

We may conclude, then, that arrowing is not desirable in late varieties, nor in fields that are to be held for cutting at the last of the crop since it checks growth too early, thus limiting tonnage and it may lead to losses from rotten cane. On the other hand free arrowing may be a distinct advantage in an early cane that is to be cut during the first part of the crop, since, as seen by the foregoing analyses it may frequently at that season give as much as 2 per cent more sucrose while the loss of growth and tonnage would then be negligible.[1]

THE RIPENING OF CANE

It has already been stated that the richness or sugar content of cane depends more on the state of maturity than it does on variety. A well-grown, fully ripened cane of the poorest variety will contain more sugar than a green, immature cane of the richest kind. Different varieties ripen very unevenly, some maturing early and others late. This shows the inadvisability of mixing them together in the same planting. After full maturity is reached cane begins to deteriorate. Cases of top rot often appear and joints injured by borers or by other causes may begin to rot. If a second growth sets in, a portion of the crystallizable sucrose will revert to glucose. All of these causes tend to lower the sucrose content and purity of cane that has become over ripe. The length of time after maturity before deterioration sets in varies with different varieties and with weather conditions. Thus Otaheite goes to pieces quickly. It must be cut as soon as it is fully matured in order to avoid heavy losses. Cristalina, on the other hand, usually remains long in good condition. If the weather remains dry it will stand in the field for weeks or even months with no loss of sucrose or purity. Heavy rains during the grinding season always result in losses of sucrose since they not only start the cane into new growth but tend to also favor growth of rot-causing organisms. Here again the question of the variety is of great importance since some start new growth with germination of the side buds much more easily than others.

The ripening of cane depends on a number of factors. The nature of the variety is one of the most important since some kinds are mature enough at ten months, with other conditions favorable, to give a very satisfactory yield, while under the same conditions other kinds

[1] It is very likely, however, that the flowered stalks are simply the oldest in the stool.—A. H. B.

will not be at their best under fifteen or eighteen months. The amount and distribution of rainfall or of irrigation is the one most important factor. The highest sugar content is never reached until vegetative growth has entirely stopped. This does not happen as long as the soil is abundantly supplied with moisture. The highest sugar yields are found always in countries with a pronounced dry season during grinding. In countries with continuous rainfall the cane never becomes fully ripe. For this reason in irrigated countries it is the custom to withhold the water for a time previous to the cutting in order to ripen the cane. Temperature is another factor. Cool weather promotes the ripening, while heat induces growth. Soil conditions, too, have a considerable influence on ripening. On porous, well-drained lands cane ripens earlier than in low, moist, retentive soils. As a rule, hill lands are earlier than low lands. The chemical composition of soils and of the fertilizers used also have a marked effect on maturity. Abundance of nitrogen and probably also of potash tends to prolong the season of active growth and hence delay the ripening. Fosforic acid, on the other hand, has some tendency to promote early maturity. The first crops of cane on virgin timber land are notoriously low in sucrose content. After three or four cuttings the cane becomes much sweeter. This is mainly because the over-supply of nitrogen on new land unduly stimulates vegetative growth and prevents ripening. All of these factors should be carefully considered in selecting varieties for these different classes of lands. It is an evident mistake to plant such vigorous, low-sucrose, late-maturers as Yellow Caledonia, Cavangerie or B 3412 on rich, new lands where it is certain that they will not mature sufficiently to be worth grinding. It is equally a mistake to plant high-sucrose canes like B 208 in poor, dry soils where it can not possibly be expected to yield a profitable tonnage. Again, in the selection and use of fertilizers it may be profitable to force high-sucrose kinds like the Rayada or Cristalina with heavy applications of fertilizers high in nitrogen, while for the lower sucrose canes like the Yellow Caledonia less nitrogen and more fosforic acid are clearly indicated.

Cultural methods, too, may have some effect on maturity. In some countries the trashing of the cane by stripping off the dead adhering leaves is widely practiced with the view of letting in more light and air and thus hastening maturity. Under Porto Rican conditions this does not seem to be profitable. The operation of tillage are all calculated to increase the vegetative growth of the cane, but after

the cane closes these are discontinued and so do not interfere with normal ripening.

The approach of maturity or ripeness is indicated in several ways. Usually there is a noticeable change in the color of the stalk. Green canes tend to turn yellow and red or purple canes become duller in color or some of them turn brownish or olive. The leaves, too, become pale and in many kinds there is more of a tendency to droop and to be less erect than when the cane is in active growth. Arrowing is, of course, a sign of maturity. Canes with the arrow in full flower quite uniformly show one to two per cent more sucrose than those in the same row that have not arrowed. It is a mistake, however, to assume, as is done by some writers, that flowering marks the time of greatest sucrose content. This is far from being the case as shown conclusively by the figures given on another page. The fact that a field has flowered freely can not be taken as evidence that it is necessarily ready for cutting. Judging just when a field of cane is in the best condition for cutting is a matter requiring much practical experience. It is also a place where practical men are often at fault. Many a fine field of vigorous, heavy-tonnage cane is sacrificed by cutting it too early when by leaving it a few weeks longer the gain in sucrose would have been great. The present system of buying cane from the *colonos* on a tonnage basis constantly tends to the grinding of immature cane with a corresponding heavy loss in sugar yields. While the trained eye of the field man can judge fairly well in most cases as to the ripeness of the cane the final judgment must be given by the chemist. Preliminary hand-mill analyses should always be made when there is any doubt as to the ripeness of a given cane. This should particularly be the case with the newer and less well-known kinds. Each per cent of additional sucrose in the cane of a forty-ton crop means 600 pounds more sugar per acre in the bags.

THE DETERIORATION OF CANE

It has been noted under the last heading that after reaching full maturity cane becomes over ripe and begins to deteriorate in the field. The rate and extent of this deterioration depends very largely on weather conditions, being much less in periods of continued dry, cool weather, and greatest when heavy rains follow a period of prolonged drouth. In cold climates where frost occurs this greatly accelerates deterioration. In such climates it is often necessary to cut and windrow the cane so that it may be protected from freezing. The amount of deterioration, too, will depend largely on the abun-

dance of borers, white grubs or other insect pests that may injure the cane and on the presence or absence of the various organisms connected with root disease and top rot. An extreme case of rapid deterioration and heavy loss from these combined causes is detailed in this JOURNAL, Vol. 4 (1): pp. 16–26, under a discussion of Root Disease. The same citation serves, however, to also demonstrate the great importance of the influence of the variety in a discussion of this question. Of the 171 varieties reported on in this experiment eight showed no appreciable loss when harvested, three were a complete loss, all having died from top rot and rind disease, while the others showed all possible variations between these extremes. Since no analyses were made the notes taken could only consider the evident and complete loss caused by the death of the cane. Had it been possible to make a series of analyses of these plots the results would have been very interesting in showing to what extent the canes which did not die of the different varieties were actually deteriorating and going off in sugar content. With the immense amount of work that has been given to sugar-cane analyses in different parts of the world it is really remarkable that so few cases are recorded where the chemical condition of the cane in the same plot has been followed throughout the season and has been, properly correlated with growth and weather conditions. The interesting work done at this Station with Yellow Caledonia cane (see paper by the Director, E. D. Colón, Ins. Exp. St., Circ. 33) needs to be repeated with each variety under cultivation, not once but several times under different conditions, before we will be able to fully judge of their desirability for different planting purposes.

After cutting, cane deteriorates much more rapidly than when still standing in the field. The amount and rate of loss varies widely according to weather conditions In Louisiana, with the thermometer near the freezing point, windrowed cane will keep for several weeks with very little loss from deterioration. On the other hand, with hot weather in the tropics serious losses may occur within three days after cutting. Too little attention is usually given to this most important subject. With the loose harvesting methods prevailing, both in Porto Rico and Cuba, where a week or more often elapses between cutting and grinding, it is certain that enormous losses are annually taking place. No reform is more urgently needed than that of so organizing the work that no cane lies more than two or three days after cutting before grinding. Losses from this source are needless except in cases of accident, and simply result from lack of system and organization. On the other hand, during the first twenty-four

or twenty-eight hours after cutting, cane often shows an apparent gain in sucrose due to the evaporation of moisture. In India this is sometimes taken advantage of by leaving the cane in the sun for a day without topping, the transpiration from the leaves resulting in a considerable concentration of the juice before grinding.

Little attention seems to have been given to the comparative keeping qualities of different varieties of cane. There can be no question, however, that some will deteriorate after cutting much more rapidly than others. It is a question of great practical importance, especially while present loose-harvesting methods prevail. It could be easily investigated if sufficient chemical assistance was available by making daily analyses from the same piles of cut canes.([1])

Cane that has been burned before cutting deteriorates much more rapidly than that which has not been burned. Accidental cane-field fires frequently occur and burning in advance of cutting is often resorted to as an aid in harvesting. If rain occurs deterioration is much more rapid than when it continues dry. In Cuba the rule at most mills is to receive burned cane up to five days after the fire if the weather is dry, but if a heavy rain falls no more will be accepted. This limit results in the grinding of much badly deteriorated cane, often almost drowning the factory in molasses, but it is extended as much as possible as an aid to the *colono* who has been unfortunate enough to have an accidental fire. When for any reason cane is purposely fired before cutting, arrangements should be such that it can be rushed to the mill and ground during the first forty-eight hours.[2] If this can be done no loss of sugar will occur, but the burning of the field may result in loss to the following ratoon crops. The practice can only be recommended in exceptional cases, as when a field is going to be immediately plowed up. There is no data as to whether different varieties have different keeping qualities after burning. Probably such differences, if any, would be slight since the burning kills the cane and thus to a great extent destroys the individuality of the variety.

LONG RATOONING

Closely connected with the keeping quality of cane in the field is the question of long rattooning. In Hawaii the custom widely prevails of letting the ratoons from late spring harvesting go over

[1] Much work along this line has been done in Argentina at the Tucumán Experiment Station.—A. H R.

[2] This is commonly practiced in Peru, where burning is almost universal.—A. H. R.

till the beginning of the second succeeding harvest, thus allowing twenty to twenty-two months' growth. These are known as "long ratoons". Fields cut early in the crop are cut again toward the last of the first following harvest when from fourteen to sixteen months old. These are known as "short ratoons". In like manner early-plant cane corresponding to our *gran cultura,* is cut during the following crop when fifteen to eighteen months old but spring plant is held over to the second year and is not cut under twenty months. The enormous yields of sugar per acre so often reported from Hawaii with Yellow Caledonia cane have all come from these old canes. They really represent two seasons' growth rather than one. Whether it is better and more economical to thus cut one big crop every two years or at best two such crops in three years rather than a smaller crop cut every year is a question that must be decided in each locality according to local conditions.[1] In Cuba ratoons are seldom allowed to go over to the second year, though this sometimes happens when rain sets in early and prevents the normal closing of the crop season. Late spring-planted cane, however, is frequently held over and is cut as *caña quedada* at the beginning or the second following crop. Many planters hold that this gives more economical results than cutting it and allowing it to ratoon, for though the total tonnage secured will be less the expenses of cultivation will also be materially less, resulting in a cheaper average cost per ton of cane. The gain will largely depend on weather conditions. In winters of severe drouth the cane becomes so weakened that much of it dies if left standing and the expected increase in yield is not realized. In such seasons it is considered best to cut all of the spring cane, even, if the tonnage is very small, rather than to let it go over. On the irrigated lands of Hawaii this difficulty in making a long crop is not encountered, but with some varieties it is found necessary to cut off the young cane after it has made two or three months' growth and force a second ratooning in order to avoid premature arrowing during the first of November, since arrowed cane can not be held over profitably. It makes aerial suckers instead of the continued growth of the stalk. Here in Porto Rico cane is very seldom allowed to go over for a long crop. In fact a large part of the Porto Rican crop is made each year from cane that is less than twelve months old. This probably accounts in great measure for the smaller average *rendimiento* or yield in sugar per ton of cane ground that is secured here as compared with Cuba and Hawaii. This custom has probably

[1] Mr. López Domínguez and the writer are now trying out this system for Porto Rico — A. H. R.

come from the long-continued planting of the Otaheite cane. This variety remained in general cultivation much longer here than in Cuba. It deteriorates faster after reaching maturity than any of the other kinds that are usually cultivated, thus forcing the short-crop system. That nothing in the local conditions prevents the successful holding over here of late spring plantings of Cristalina and some of the newer seedling canes is shown by some of the preliminary experiments carried out at this Station. In the small plots under observation damage from rats has been heavy, but otherwise the cane has come through in good condition. The comparatively frequent winter showers makes it easier to hold over cane here than in Cuba. In how far it will be more profitable to hold over late spring-planted cane rather than to cut it green during the first crop is a question that deserves the careful attention of plantation managers.[1] It will assume more importance in the future with the system of "buying by *dulce*"—that is, on the sucrose content of the cane—rather than by its gross weight, that is being adopted by some of the centrals. Some varieties will adapt themselves to a system of long cropping very much better than others, but unfortunately our knowledge on this point is limited. In a general way, the non-flowering canes will be better for this purpose than those that arrow freely, and those with strong resistance to root disease and top rot will be better than the more susceptible kinds. Here, again, it is vigor and power of resistance that will count rather than high sucrose content. These are the features that have adapted the Yellow Caledonia so well to the long cropping methods in Hawaii. The question should be carefully studied whether or not this is also the best method of handling this variety in Porto Rico.

THE BOTANY OF SUGAR-CANE VARIETIES

The true sugar canes all belong to the genus *Saccharum*, founded by Linnaeus in the first edition of the "Species Plantanum," published in 1753. He then included two species *S. officinarum* and *S. Spicatum*. The latter was not a true sugar cane and is excluded from the genus by recent authors. The number of supposed species increased rapidly. Thus Willdenow, in the third edition of the "Species Plantanum" in 1797, lists eleven species and Kunth, in 1833 in the "Enumeratio Plantarum", lists 22 species besides various varieties. Roxburg, in his "Flora of India", 1832, gives eleven

[1] Mr. W. C. Dreier has many times demonstrated the feasibility of this system at the Hatillo Fruit Farm.—A. H. B.

species for that country alone, eight of them being described as new. Hooker, in the "Flora of British India," 1897, reduces the number to five. Bentham and Hooker, in "Genera Plantarum," 1883, recognize only 12 species for the world. Hackel, in his monumental revision of the grasses in Engler & Prantl, "Pflanzen familien," 1887, also recognizes 12 species, divided into four section or sub-genera, but only two, *S. officinarum* and *S. spontaneum,* belong in section *Eu-Saccharum,* or the true sugar canes. Of these *S. Spontaneum* occurs abundantly in the wild state in India and other parts of Southern Asia and in many of the Pacific Islands. According to C. A. Barber (Punjab Canes, Mem. Dept. Agr., India (1) 1919), who has studied the wild forms carefully and used them for crossing on cultivated kinds, this is an exceedingly variable species. The diameter of the stalk varies from no larger than a straw to as much as 2 centimeters or more; the color may be red or yellow, the leaves very narrow or comparatively broad, the leaf sheaths smooth or prickly, and finally the buds may vary through most of the forms found in cultivated varieties. The evidence is conclusive that the slender cultivated kinds of Northern India (including Uba which attracted so much attention in Porto Rico because of this immunity, to mosaic disease) are nothing more than selected forms of this wild species. *S. officinarum* was founded by Linnaeus on the cultivated thick-stemmed tropical sugar canes. It has always been held that these constitutes a distinct species, but no wild representative of it has ever been found. It is distinguished from the forms of *S. spontaneum* by the usually thicker stalks and wider leaves and by the glabrous rachis and peduncle of the flowering panicle. The varieties belonging to the former species all have these parts densely hirsute. In size of stalk and leaf, however, the two series clearly tend to merge into each other. B–1753 and B–3412, for example, are only a little stouter and the leaves are not much broader than in vigorously grown Uba, and now the only really technical distinction between the supposed species gives way, for a number of the newer seedling canes have the peduncle and rachis clearly hirsute. This is notably so with P.R.–292, a seedling of D–117, and to a less degree with P.R.–260 of unknown parentage. Those of Kobus' Chunnee X Cheribon hybrids that have been examined, notably 36–P.O.J. and 105–P.O.J., have these parts as densely hirsute as the Uba. This might be held to show that other seedlings showing this character are also of hybrid origen. We have no evidence, however, that varieties of Indian origin existed in the Barbados and Demerara collections, from which most of our recent seedlings have sprung. The

more likely supposition would seem to be that this hairiness of peduncle and rachis represents a reversion to some remote ancestral type. This would go to substantiate the idea, clearly indicated by Barber, even if not openly advocated, that all cultivated sugar canes, both thick-stalked and thin-stalked kinds, are in reality descendants of the wild *Saccharum spontaneum*.

In order to describe sugar-cane varieties so that they may be recognized by others it is necessary to employ the methods and to a considerable extent the terminology used in ordinary descriptive botany or taxonomy. This was attempted in the first paper of this series (Journ. 3 (2) 1919) but with only partial success. When that paper was written the work of C. A. Barber in India and Dr. J. Jeswiet in Java had not been seen. These two writers have laid a broad and secure foundation for the study of sugar-cane taxonomy. For the first time we have descriptions of cane varieties that are sufficiently full to permit of sure identification. It is unfortunate that their studies have not included a much greater range of varieties. Their methods, while essentially similar, having originated independently, are naturally not identical. Of the two, that of Barber seems preferable since it more nearly conforms to ordinary botanical usage. Jeswiet's method of dividing the parts of the bud and other regions of the plant body into serially numbered areas for purposes of description, especially for noting the presence or absence of plant hairs, seems to introduce an unnecessary complication. In this, however, he is followed by G. L. Fawcett of the Argentine Sugar Station, who has also recently published some most useful cane descriptions. The author must be permitted to express a doubt as to the usefulness of the detailed measurements of length and diameter of different parts since these factors are so greatly altered by conditions of growth and environment.

A cane description should cover notes on all of the following points:

1st. General habit; whether erect or soon prostrate, heavy or light stooling habit, general vigor, and propensity to arrow.

2nd. The stalk as a whole; average diameter, color and bloom. Canes under 3 centimeters in average diameter are characterized as slender; those about 3 centimeters medium slender; 3 to 3½ centimeters as medium; 3½ to 4 centimeters as medium stout; and above 4 centimeters as stout or very stout. Of course such measurements refer to the average for ordinary well-grown canes, not to old, half-starved ratoons nor to overgrown suckers. Color of stalk is one of the most obvious characters, but it can be one of the most misleading,

since in many varieties color is dependent on growth, vigor and exposure to light. This is particularly true of that large number of varieties which are normally green but which show a more or less pronounced pinkish or reddish flush when exposed to light and air. In the descriptions the color refers to that of fully matured internodes that have been exposed by the falling of the leaves but which have not yet become faded or discolored. The changes in color which accompany ripening have already been mentioned, as well as the striking color changes often brought about by sporting or bud variation. Changes in location and soil often lead to marked color changes. The amount of the waxy coating or bloom should always be carefully noted, though this, too, is a character somewhat dependent on growth conditions.

3rd. *The character of the internode.*—Here should be noted comparative length, though this can only be stated in general terms, being largely dependent on growth conditions and often varying widely in different parts of the same stalk; general form, whether cylindrical or compressed or barrel-shaped, and whether it is enlarged either above or below; finally, whether or not it has a groove or furrow on the side above the bud, and if present something regarding its character.

4th. *The nodes.*—Whether constricted, even, or prominently enlarged; and whether at right angles to the stalk or oblique. The node consists of several elements. Under it should be noted—

(*a*) *The growth ring.*—This is a narrow region separating the node from the internode above. It may differ from the internode in color or be concolorous and it may be sunken, even, or elevated. The width is also quite variable. The cellular tissue of this region remains in a plastic growing condition much longer than the rest of the stalk, and by the division and growth of the cells on the lower side it enables the younger growing part of the cane to again assume an erect position when it has been thrown down by storms or prostrated by its own weight. In the first paper this was referred to as the "limiting ring" since it marks the limit between the node and internode, but for the sake of uniformity it seems best to adopt Barber's very appropriate name which refers, of course, to this continued power of growth of the cells in this region.

(*b*) *The root band.*—This name is applied to the space between the growth ring and the point of attachment of the leaf sheath. In different varieties it varies from about 6 to as much as 12 milimeters in width. It is usually of a somewhat different shade of color from the internode and is marked by irregular encircling rows

of rounded dots which mark the ends of rudimentary roots. These quickly grow out and form a root system when cuttings are planted in moist soil. In some varieties, especially if the weather is wet, they spring into growth prematurely on the standing cane. The number of rows and the color, size and prominence of the rudimentary roots should be noted.

(c) *The leaf scar.*—This is a remnant of the base of the leaf sheath which remains on the stalk when the leaf falls away. It is usually prominent or squarrose under the bud and may be so on all sides, but it more often closely appressed to the stalk behind on the side away from the bud. In very young joints of cane there is usually a conspicuous circlet of long hair on the base of the leaf sheath. They are usually deciduous, falling away before the maturity of the leaf and thus leaving the leaf scar glabrous. In a few varieties, however, they are persistent, leaving the leaf scar conspicuously ciliated. This is usually a constant character of considerable importance.

(d) *The glaucous band.*—This name is applied to a region usually about a centimeter wide immediately below the leaf scar which is characterized by a heavy deposit of wax even in those varieties in which otherwise this material is scanty or wanting. In fact, it is in the kinds with little bloom that the glaucous band is most conspicuous since it is more or less obscured by a general waxy coating or bloom. This band is often though not always conspicuously sunken or constricted. It is sometimes this and sometimes the root band that constitute the narrowest part of the stalk. In some cases, however, particularly with some of the North Indian canes, these parts are conspicuously swollen, being of a considerably greater diameter than the internodes.

5th. *The buds.*—These give us characters of greater taxonomic importance than any other part of the cane. Bud characters are less variable and less dependent on growth conditions than any of the others, and it is on their careful description that we must mainly depend for recognizing varieties. If this had been thoroughly understood by the older writers on cane varieties it would have prevented much of the unfortunate confusion found in the literature of this subject. Although affording the most stable characters of any part of the cane plant, the appearance of the bud varies greatly at different ages and stages of development and some judgement and experience is required to determine whether or not a given stalk shows buds that are in a typical condition. Unless otherwise stated, bud descriptions should apply to those that are fully grown and

developed but which have not started to germinate on the standing stalk. With some varieties this happens very promptly after the bud is mature and it is often difficult to find buds that are in a condition to be really typical After arrowing it is usually difficult to find buds that are in good condition As a rule cane that is about ten months old is in the best condition for study

Under the buds should be noted the general form, whether lance-

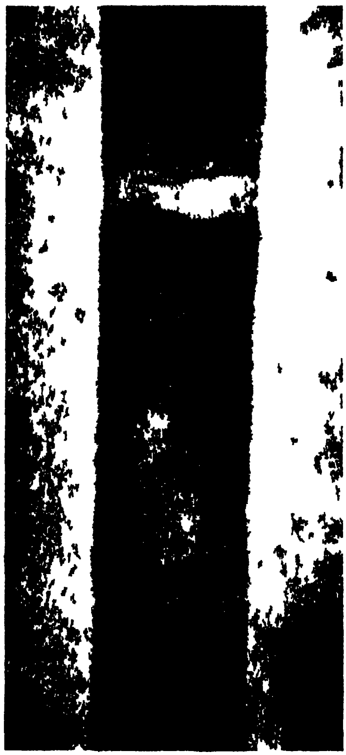


FIG 1—Well marked constricted glaucous bands of B 1596

olate, ovate, oval, suborbicular or broader than long, the apex, whether acute or obtusely rounded, the flat sterile margin, whether narrow and uniform in width, broad and uniform or shouldered, that is abruptly widened below, the point of germination, whether apical, subapical, subdorsal or dorsal so called when the germinating point issues near the center of the bud and not at or near its apex; the average size should be given, especially in relation to the other ele-

ments of the node. In some cases the buds do not reach to the growth ring, while in other varieties they may exceed it by as much as

FIG. 2—Elliptic ovate bud of Otaheite

FIG. 3.—Ovate but of D-117

half of their length, finally the presence or absence of hairs should be noted, especially at the base, on the sides, and at the apex. In a few kinds the entire back of the bud may be hairy. This character

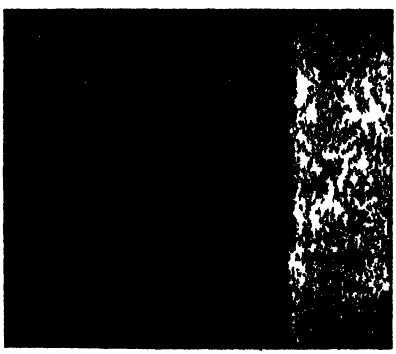


FIG 4.—Bud exceeding growth ring by one-half its length

is often obscured in buds where mealy-bugs have been feeding. Such buds should not be selected for study.

6th. *The leaf sheath.*—In many varieties the leaf sheaths have a dense vestiture or coating of sharp, stiff hairs over the greater part of their surface. This was often referred to as "cane itch" by the older writers, since these sharp hairs prick and irritate the skin of persons handling the cane. This vestiture may be persistent or it may be more or less deciduous, appearing only on the younger sheaths and falling off at maturity. Its general character and abundance and the color of the hairs should be noted. In many other varieties this vestiture is reduced to a few scattered hairs along the median line on the back of the sheath or it may be entirely absent. Such sheaths are called "glabrous", or if only a very little hair is present "glabrate". If much wax appears on the sheath it is caleld "glaucous". The color is usually green but it may be tinted with red or purple and in some varieties it is quite dark purple. In connection with the sheath should be noted—

(*a*) *The throat.*—This is a discolored, usually more or less crumpled or wrinkled area in the axil of the leaf where the blade joins the sheath. It is usually lannate, that is, coated with numerous short appressed, wool-like, more or less felted hairs, but it may be only waxy or glaucous. Usually also there are conspicuous tufts of long hairs. All these characters should be noted.

(*b*) *The collar.*—This is the corresponding region on the outside of the leaf. It consists of two or more clearly marked triangular discolored areas which may or may not meet and coalesce at the midrib. The surface may be lannate or only glaucous.

(*c*) *The ligule.*—This is a short, circular, brown, somewhat horny membrane that clasps the stalk at the base of the leaf blade. It varies somewhat in length and shape in different kinds and the edge may be nearly even or conspicuously fimbriate or fringed.

(*d*) *The ligular process.*—This name is applied by Barber to the coriaceous triangular outgrowths or lobes seen in some varieties at the upper corners or shoulders of the leaf sheaths. These may be large or small, broad and obtuse or slender and acute. They may be present on one shoulder only or on both, or they may be entirely absent.

7th. *The leaf, or more properly, the leaf blade.* The general position should be noted, whether spreading, erect with the tips declined or strictly erect. The color may be light green or yellowish green, dark green, or glaucous or bluish green. Measurements of the average width should be given. Finally, the character of the serrations on the margin should be noted as well as the presence or absence of long straggling hairs or cilia on the margins near the base.

8th. A full descriptoin should include the characters of the arrow or inflorescence, since this is likely to afford many points of value. The arrows are only in condition for study for a brief period and in many varieties they are seldom or never produced. For practical purposes, therefore, it seems best to largely ignore the characters afforded by them. A tendency to free arrowing or the reverse should, however, always be noted.

THE SUGAR-CANE SOILS OF PORTO RICO

In judging of the agricultural value of the different varieties, it is frequently necessary to refer to the different soil types to which they are adapted. To do this intelligently it is necessary to consider briefly the different kinds of soil on which cane is grown in Porto Rico.

Unfortunately, existing knowledge is very limited regarding Porto Rican soils and their classification. No comprehensive study of the soils of the Island ever seems to have been undertaken. Some years ago the Division of Soils of the United States Department of Agriculture made some preliminary studies in cooperation with the Mayagüez Station and a report was published with a soil map in colors covering north-and-south section of the Island from Arecibo to Ponce. This covers at least two important cane-growing districts and should have been of basic importance for the present purpose. Unfortunately, like so much of the work of this Division, it is largely lacking in practical value The classification seems to have been based on the mechanical analyses of the surface soils with scant attention to geological derivation and subsoil conditions, both points having a profound bearing on drainage and general cultural adaptabilities. It is disturbing to find the same name applied to soils in the coastal plain near Arecibo and to those many miles among the hills of the interior.

The following tentative classification of the cane lands of the Island is based on their most obvious geological and agricultural characteristics and makes no claims to being anything more than an aid in the discussion of varietal adaptabilities. The first five numbers are the more recent geologically, belonging to the mangrove swamp and coral-reef formations, while the last three belong to the older central mountain mass of the Island.

1st. *Maritime Soils.*—These were originally deposits formed at the bottom of salt-water lagoons and estuaries. Each barrier reef cuts off a lagoon of quiet water which gradually fills up with sedimentary

deposits. Finally it usually grows up to mangroves, and at last by the continued accumulation of sediments and fallen leaves it is built up above the ordinary tides and becomes usable land, or it may be elevated by oscillations in the shore level Much of the best cane land in Porto Rico is of this origin. Practically all of the sugar of Demerara is grown on such lands They are usually stiff and intractable and difficult to work Being of an impermeable nature, lying so flat and low, drainage is a first requisite, and good drainage is often difficult to secure on account of the impossibility of finding a sufficient outlet. These lands are very rich, but when long in cultivation they become very compact, and without careful cultivation cane, and particularly ratoon cane, suffers from root disease caused by lack of drainage and aeration Most of these lands still retain a certain amount of salt, and in many places, especially on the dry south coast, they are too salty to permit of cane growing They are roughly divided by planters into *poyals*, *semi-poyals* and *vegas*, in accordance with their elevation above sea level The *poyals* are really marshes They are only slightly above sea level and standing water can always be found in the drainage ditches, as a rule, cultivation must all be done with the hoe The *vegas* are sufficiently elevated to be above standing water They may be prepared and cultivated like ordinary uplands, but these operations are impeded by the necessity for numerous drainage ditches As the name indicates, the *semi-poyals* are intermediate between the other two

2nd *Alluvial Soils*—These are the deposits formed by running water They always form the bottom lands along streams and in Porto Rico, especially on the south coast these deposits spread out and cover a considerable portion of the coastal plain These soils are usually lighter in texture and much easier to work than the maritime soils, and as they are often built up from alternating deposits of silt, sand and gravel they are not so retentive and are easier to drain The very best sugar lands of the Island are of this type These lands are also called *vegas* in Porto Rico, which is unfortunate since their cultural requirements are quite different from the *vegas* discussed under the last heading

When alluvial deposits have all come down from red shale clay hills (described under No 6) as happens at both the eastern and western ends of the Island, in the Fajardo and Mayaguez-Añasco districts, the resulting soil, being unmixed with sand as in ordinary alluviums, is as heavy and compact as on the hills from which it came, and from its retentiveness it also presents a difficult drainage

problem. These clay alluviums are not so rich as the maritime *vegas* and they are equally difficult to cultivate.

3rd. *Dune Sands.*—Along the north and east coasts there are considerable areas where the soil is more or less mixed with wind-blown sands. These are really cocoanut and not cane soils, but considerable areas of cane are found planted on them. They vary in consistency from the almost pure sand of an actual dune to sandy loams where there is a considerable admixture of the red soil discussed in the next paragraph. As cane soils they are of but little importance and no attention has so far been given to selecting varieties particularly adapted to them.

4th. *The Coral Red Lands.*—This is an exceedingly important soil area occupying the valleys between the coral limestone hills all the way from San Juan to Aguadilla and extending back into the interior almost to Utuado and Lares. This soil is red in color. Under forest conditions there may be a shallow surface of black mould, but this soon disappears under cultivation. It seems to be the residue left from the weathering of the coral rock and the dissolving out of the carbonate of lime. In texture it is a fine silt, more or less admixed with sand. There is no subsoil, but the deposit goes down unchanged to the coral bed rock whether it be only 6 inches or 60 feet. It is sufficiently open and permeable for the rainfall to pass through it readily so that drainage ditches are not required. Crops are seldom or never injured by too much rain on these soils, but they often suffer seriously from drouth. When first cleared these lands are sufficiently fertile, but on account of their porous nature they leach and become exhausted much quicker than more retentive soils. The famous red-cane lands of Cuba and also those of Barbados are of this same general nature, though the Porto Rican red lands have rather more of an admixture of sand than those of Cuba.

5th. *The Black Calcareous Soils.*—These also belong geologically with the coastal coral deposit, but they seem to represent an earlier formation than the red lands and they are quite different agriculturally. They consist of a black loam that is usually rather shallow and which is underlaid by a soft white deposit of carbonate of lime. The area of these lands is not large in Porto Rico. They have been noted near Bayaney on the north side of the Island and on the lower foot hills near Yauco and Ponce on the south side. In Cuba lands of this general character occupy very extensive areas in Havana,

Matanzas and Santa Clara Provinces. Next to the "red lands" they comprise the most important cane soils of the Island.

The above five groups comprise all of the cane soils derived from the more recent formations of the coastal region. The following three are the only areas of consequence, planted to cane, derived from the central mountains mass of the Island.

6th. *The Red Shale Clay.*—These soils occupy extensive areas in the foothills, especially on the northern side of the central mountain mass of the Island. They may be found all the way from Fajardo to Mayagüez. In color they closely resemble the coral red lands discussed under No. 4, but they are very different in cultural characters, being tough and impermeable while the former are open and porous. Although difficult to properly prepare and cultivate, they are naturally strong soils and give good yields when properly handled. Large areas of them are planted in cane. The yields secured are usually small, but they could easily be greatly improved by the proper selection of varieties and by better tillage. Like the stiff maritime coast lands, they require frequent cultivations to prevent them from becoming too compact for plant growth. The old methods of hoe cultivation do not give good results on these soils, especially after the humus is exhausted by constant cropping. Green manuring with legumes and better tillage will work wonders on these lands. The application of lime or ground limestone is also very beneficial to them, although it would be worse than useless on the black lands discussed under No. 5.

7th. *Sandy Loam Hill Lands.*—These are really tobacco rather than cane lands, but considerable areas of them are planted in cane, especially between Juncos and Humacao and in the Cayey district. They seem to have been derived either from decomposed granite or from the so-called volcanic ash that constitute the bed rock in some part of the central mountain region. They are of minor importance to the cane industry.

8th. *Black Hill Lands.*—At other parts in the hill lands are found rather heavy black soils with a yellow clay subsoil. These are usually marked by scattered masses and boulders of a hard blackish rock, the nature of which has not been determined. Considerable areas of these lands are planted in cane, particularly in the districts about Juncos and Trujillo Alto. They are among the best of the hill lands for cane.

HISTORY OF SUGAR-CANE VARIETIES IN PORTO RICO.

Sugar cane was taken by Columbus to Santo Domingo on his

second voyage in 1493, but this shipment was lost. Cane seems to have been first grown in that island in 1507, but the first sugar was manufactured there in 1509. From Santo Domingo cane was soon carried to Porto Rico, but the exact date of its first establishment has not been ascertained. The first sugar mill in Porto Rico was established at San Germán about 1524. The first cane to be imported was the Criolla variety (Creole) and it was the only kind grown here for two hundred and fifty or more years. It came originally from India by way of Arabia and Spain.

In the early years of the nineteenth century this kind was rapidly and quite completely superseded by the Otaheite or Caña Blanca. Just when or by whom this cane was first brought to Porto Rico is not known. It was carried to Cuba in 1795 by Francisco de Arango and it probably reached this Island only a little later. At about the same time, quite likely as an admixture in this first importation, a few seeds reached the Island of the kinds now known as Cristalina, Rayada and Morada or Louisiana Purple. These attracted no attention and were not planted in separate cultures until after the epidemic of 1872. They were simply strays occasionally seen in fields of Otaheite, which for seventy-five years after its first importation continued to be the only variety intentionally planted.

In 1872 attention was first seriously called to a disease or epidemic that was devastating the fields of Otaheite cane in the district about Mayagüez on the western side of the Island. To this day the nature of this outbreak is unknown. It gradually extended until the entire region between San Germán and Arecibo was involved. Various commissions were appointed to study it. Its cause could not be determined and no effective remedy was found. It was noted, however, that these other kinds occasionally mixed with the Otaheite were much less injured. They were finally selected out and planted instead of the susceptible Caña Blanca, and as in so many other instances this was the only practicable means for combating this cane disease. This naturally led here, as in other countries, to a great interest in cane varieties and a considerable number of other ones were imported in the hope of finding still better and more resistant kinds. A full account of this interesting experience has come down to us through the effort of Dr. Agustín Stahl of Bayamón, who gathered together the reports of the various commissions, of one of which he was a member, and published them with various comments of his own in a pamphlet of 138 pages entitled "La Enfermedad de la Caña de Azúcar en Puerto Rico", dated 1880.

From the "Memoria de la Enfermedad de la Caña de Azúcar", by Antonio Ruiz Quiñones, dated August 1877, as quoted by Dr. Stahl, it seems that at some time prior to that date there had been an importation of Cristalina from Cuba. He also mentions another importation from Cuba made apparently just prior to this date by Patxot, Castello & Cía. of Cabo Rojo, owners of the Hacienda Monserrate, of three kinds called Caña Cristalina de las Indias, Caña Cristalina de Otaheite and Caña de Cintas Moradas de Bengala. From the descriptions these seem to have been respectively, Cristalina, Calancana or Green Ribbon and Rayada. Calancana or Green Ribbon is thus the only variety introduced into the Island prior to this outbreak of disease aside from the five that had been here since the early days of the century, namely, Criolla, Otaheite, Rayada, Morada and Cristalina. Interest in introducing new varieties now became active. Dr. Stahl established a nursery at Bayamón for the propagation of new kinds and the sale of seed cane. In the *Revista de Agricultura, Industria y Comercio* for 1887, page 174, is an article describing this nursery and listing the following varieties and the prices at which seed could be obtained:

Cavangerie	Palo Rojo Claro
Criolla	Gigante
Cristalina	Imperial del Brasil o Calancana o Carandali
Lajaina o Borbón	Reina de Caledonia
Kakoe	Salangore Blanca
Otahití o Blanca	Salangore Rayada
Malabarde o Morada o Listas	Salangore Roja o Morada
Moradas	Saconi (Sacuri)
Palo Rojo	Tamarin

In the summary of his work on the cane disease, page 134 (1880), Dr. Stahl mentions 23 varieties and gives partial descriptive notes. Saconi and Kakoe are not included and to one he gives no name. Those not included above are the following:

Bambú Rosada	Pinang
Bambú Rosada de Rayas Moradas	Rosada—Morada
Diard	Verde Zic-Zac
Lousier	

Fernando López Tuero, who was Director of the Spanish Agricultural Experiment Station located at the farm Las Monjas near Río Piedras, published a book in 1895 entitled "Caña de Azúcar". He lists 22 kinds that he has known in Porto Rico. This list corre-

sponds closely with that of Dr. Stahl the only additional names being as follows:

Bengala	Guingham	Polvo de Oro

From a foot note, page 10, we learn that Carandalí, Salangor, Cavangerie, Palo Rojo, Tamarín, Pinang, Diard, Rosada Morada and others were introduced prior to 1879 from Jamaica, Guadaloupe and the other Antilles by Dr. Grivot Grand-Court of Mayagüez and that Reina Caledonia and Gigante were brought from Trinidad by Dr. Stahl.

This completes the history of cane introductions prior to the American occupation in so far as it has been possible to trace.[1] Very few of these kinds have been maintained as pure cultures in any part of the Island. Such of them as still exist are scattered through the fields in mixed plantings. Tradition has handed down the names of some of them, but of others even the names are forgotten. The attempt has been made to gather up these forgotten kinds from all parts of the Island and to bring them into the experimental plots at this Station for further study. When a name could be associated with them it has been provisionally retained. Otherwise they have been given serial numbers under the letter "X" to indicate that they are unknown. The attempt to identify them has led to a rather exhaustive search of all available sugar-cane literature. In some cases this has been successful, but many of these strays are still held under their X numbers. Some of them are evidently of considerable value and it is strange that they have not come into more general cultivation. No one in Porto Rico since the time of Dr. Stahl seems to have given the question of the old cane varieties the attention which it so rightly deserves. The mere fact that mixed plantings are almost universal shows how completely it has been diregarded. This careless custom of mixing different varieties in the same planting is costing this Island literally millions of dollars annually.

The American occupation and the bringing of Porto Rico inside

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(1) The following interesting communication was received from Mr. E. D. Colón, covering some more recent historical investigations:

"GOVERNMENT OF PORTO RICO,
"DEPARTMENT OF AGRICULTURE AND LABOR
"INSULAR EXPERIMENT STATION

"Río PIEDRAS, P. R., *mayo 22, 1921.*

"SR. DON F. S. EARLE,
"Estación Experimental Insular,
"Río Piedras, P. R.

"MI ESTIMADO MR. EARLE:

"Decidí ayer reunir, antes que algo me impidiera hacerlo antes de su partida para Cuba, los datos más significativos que tengo en mi poder con respecto a las variedades

de la caña de azúcar que existían en Puerto Rico en 1878 y las importaciones hechas entonces hasta 1880.

"Los he obtenido, a propósito de mis investigaciones sobre la agricultura de Puerto Rico antes de 1898, de los archivos de la Diputación Provincial de Puerto Rico, del expediente intitulado 'Incidentes de los expedientes sobre la enfermedad de la caña de azúcar y comisiones nombradas con tal motivo por el Ayuntamiento, Centro Hispano Ultramarino y Sociedad de Agricultura de la Ciudad de Mayagüez,' Número 5, legajo 17; y, a propósito de las respuestas dadas por los hacendados de la Isla a un interrogatorio enviádoles por la Comisión Permanente de la Diputación Provincial acompañando el Informe dado a la Excma Diputación Provincial sobre la Enfermedad de la Caña de Azúcar en el 4º Departamento de la Isla de Puerto Rico por los Comisionados al efecto, Dres D C Grivot Grand Court y Don Agustín Stahl, y Lcdo José Julián Acosta y Calbo

"A excepción de algunas notas explicativas, me ha parecido que haría más interesante este informe el citar directamente aquellas porciones contentivas de los datos que creí más significativos Siguen a continuación

"1. 'La de lista verde se encuentra en abundancia en algunas haciendas de Guánica' Carta de L Bas Nadal de Mayagües al Sr Presidente de la Diputación Provincial bajo la fecha julio de 1878

"2 ' entre la cual (la caña Blanca) se encuentra bastante de listas verde llamada vulgarmente (Carandalí) En 1870, cuando fomentamos la plantación por necesidad tuvimos que sembrar, mesclada con la Blanca, mucha de la morada y de la morada de listas, pero las hemos extirpado por su escaso rendimiento y mucha dureza Tenemos ya una cepa de Salangore que nos proponemos multiplicar y la Salangore que existe hoy plantada en diversos puntos, presto dará a conocer sus buenos o malos resultados La caña Cristalina que existe en esta Isla ha venido de Cuba, según entiendo, y la Salangore de Jamaica' *Idem* de Don Pablo Morales, julio de 1878

"3 'Desde esa fecha (cosecha del 77) acá, viendo que la enfermedad en esa clase de caña (Blanca) es tenaz y hace cada vez mayores estragos, resolví y he podido conseguir plantar algunas semillas de caña "Cristalina' y la conocida vulgarmente de "Cinta" traídas de la Isla de Cuba

"En lo que va de este año he importado de Barbados (20 barriles) semilla de caña Blanca que allí llaman de 'Bourbón', pero que a juicio de los pocos, pequeñísimos conocedores de la planta se designa con el nombre también de 'Belouguet Blanche', caña que tampoco florece, según de Barbados escriben

"En poquísima o en pequeñísima cantidad he empezado a formar semillero de la caña *Carandalí* o *Calancana* Esta clase de caña me dicen la hay en la costa Este de la Isla (Humacao, Naguabo, Fajardo, etc) y según voces su rendimiento satisface a aquellos hacendados, tanto, que la propagan cuanto pueden

" 'Como prueba positiva hice sembrar en 1877, en magnífico terreno y en gran cultura ocho cuerdas de caña morada o prieta que mucho se conoce en el país por su antigüedad, pero el poquísimo rendimiento al molerla este año me ha hecho desistir de su cultivo en adelante

" 'De lo expuesto que tengo en mi Hacienda Josefa, una de las más castigadas en el Departamento por la enfermedad, seis variedades de cañas a saber

' 'La *Otahití*, que es la atacada de la tisis

' 'La *Cristalina*, de Cuba, que no deja de prometer,

" 'La *Cinta*, veteada de morado y amarillo, también traída de Cuba que no la conceptúo sino de mediano rendimiento,

' 'La *morada* o *prieta*, que trato de desechar

" 'La *Bourbon* o *Bellouget Blanche*, importada de Barbados,

" 'La *Carandalí* o *Calancana*, veteada de amarillo y verde, traída o conseguida en un cafetal del interior del Departamento'

Idem de Don José A Annoni, Hormigueros, julio de 1878

"4 'En cuanto a lo que se dice en el "Informe" de que la caña Morada resiste más, nada tiene de particular si tomamos en cuenta que mucho antes de conocerse dicha enfermedad en la Isla ya se sabía que la caña Morada en terrenos estériles es mucho más vivaz que la Blanca '

Idem de Don Francisco Salichs, Humacao, agosto de 1878

"5. 'Al contestar dicha carta debo hacerlo siguiendo las preguntas que la misma encierra, a saber

" '1º Las cañas que tengo en cultivo en esta finca son a mi corto entender, cinco clases

" '*Primera* Caña morada o bambú, de la que queda muy poca en esta finca, pero abundaba anteriormente, y voy haciendo desaparecer por no ser partidario de ella,

" '*Segunda* Las Guingans, o cañas de cinta morada y verdes, de las que hay muy pocas

' '*Tercera* Las bambús blanches o de cintas verdes y blancas, también en pequeño numero

' *Cuarta* La Blanca de Otaití que es la que se cultiva en mayor escala y

' '*Quinta* La caña verde, verdadero bambu por su forma, y que existe en bastante abundancia en la finca pero ligada en los mismos tablones a la caña de Otahití Esta caña por su desarrollo su buena vegetación y el rico jugo que encierra, trato de estudiarla haciendo de ella semilleros con ese objeto pues creo sea más ventajosa en esta jurisdicción que la caña de Otahití Se conserva siempre lozana y verde y aún en el tercer corte la veo sobresalir en desarrollo a la Otahití Ignoro su verdadero nombre y cómo haya sido introducida en esta finca pues la encontré ya aquí en el año 71 '

Idem por D S !, Hacienda Carmen Vega Alta, agosto 4 de 1878

' 6 Entre ellas (plantaciones de caña Blanca o de Otahití) se encuentran sin orden ni colocación meditada y sólo al acaso algunas cepas de caña morada y alguna que otra de la de listas Estas, en nuestro concepto, provienen de la morada misma, que en una sucesión de años que no podemos precisar, sufre esas transformaciones, ya en la propia cepa ya en otras que de su semilla producen ' *Idem* por L Igaravídes, José G Padilla, Francisco Alero, Vega Baja Puerto Rico

"7 Que existiendo con alguna abundancia la caña de cintas verdes, llamada *Carandalí* o *Calancana* en la costa Este de esta Isla (Humacao, Fajardo, Naguabo, y en los campos de Toa Alta y las Vegas), se envíe a costa de esta Excma Diputación la mayor cantidad posible de semillas de la misma al 4º Departamento y que se repartan entre aquellos hacendados ' Comunicación al Señor Comisario de Administración Local de la Excma Diputacion Provincial por Don Ramon Power, noviembre de 1878

'8 los informantes añaden que por mucho cuidado que se ponga siempre se perderá un 50 por ciento de las semillas importadas de Oriente, como ha acontecido con las encargadas por el tantas veces citado, Dr Grivot Grand Court Informe de su Comision a la Sociedad de Agricultura de Mayaguez, junio 28 de 1879

"Desde el 1875, Don Santiago McCormick de San Juan hacía propaganda para la importación a Puerto Rico de nuevas variedades de cañas, habiendo dado a la publicidad en el Boletín Mercantil del 3 de julio de 1879 datos sobre ciertas variedades de caña aclimatadas entonces en Trinidad introducidas de Oriente e islas del Pacífico, por Mr H Prestoe, Director de los Jardines Botánicos de Trinidad en esa época y amigo personal del Sr McCormick desde hacía 25 años

"En 1º de agosto de 1870 acordó la Diputación Provincial el envío de Don Santiago McCormick a Trinidad para la importación de nuevas semillas de cañas En noviembre 10 de 1879, de regreso ya, daba cuenta el Sr McCormick a la Diputación Provincial de haber llenado su cometido

' 9 'Nota del contenido de 42 barriles de semillas de cañas introducidas de la Isla de Trinidad por encargo de la Excma Diputación Provincial

" '23 barriles semillas de la Reina Caledonia [1]

No 1—Barril con Salangore Verde [2]

[1] Caledonian Queen Cane is a pale or greenish purple cane, close jointed, and extremely vigorous The leaves are remarkably broad and their bases are nearly destitute of the setae or cowitch common in most canes This cane is said to attain enormous dimensions in the East and to be one of the most sacchariferous The short joint is a feature which is generally considered objectionable—accompanied as it usually is by great hardness of cane tissue In this respect however the Caledonian Queen Cane is an exception, and the ready way in which both length of joint and diameter of cane are affected by manure—the natural soil at St Ann s being the poorest—indicates great variability of habit, and suggests gigantic growth under the influence of rich alluvium

[2] The green Salangore is so named from its retaining a green color on the cane much longer than usual, although when fully ripe the color of the cane is yellow, but not so bright a yellow as that of a well ripened Otaheite This variety is the freest growing of all the varieties in the Gardens except the giant Claret Cane, and its *erect* habit is even more striking than in that variety Both in respect to length of joint and diameter of cane it is equal to it—thus being the largest yellow cane grown here The foliage is large and heavy as in Nos 1 and 2 and 6 of the former series, but completely deciduous so that the operation of trashing" is with it reduced to a minimum The most striking feature of this cane—besides its size—is the broad white ring just below each joint

of the American tariff lines gave the sugar industry a great impetus. Several large American factories were established and the Federal Experiment Station at Mayagüez was founded.

The next introduction of cane varieties seems to have been due to the initiative of that institution. Its activities in connection with cane varieties are outlined by Director D. W. May in a letter dated January 11, 1921, as follows:

"The first brought into the Island was in December 1904, when we received from the Station at Audubon Park, Louisiana, the following: D-74, D-95, D-117, T-77, B-347, Louisiana Purple, Louisiana Striped, Tibboo Mird, White Bamboo, and Rose Bamboo. Since that time we have received a great many seedling canes from the British Islands, especially Barbados. Other countries from which we have received seedling canes are Java, Mauritius, Egypt, Demarara, Martinique, Argentine and the Virgin Islands. The Station began breeding cane in 1906. Some very good varieties were produced and distributed over the Island. When the Sugar Planters' Station was established we stopped the breeding of canes as it was undertaken there. We have again taken it up in the last three or four years. There have been so many canes bred on the Island and sent out not only by this Station but by Guánica and Fajardo Sugar Companies that the question of varieties is intolerably mixed."

The writer wishes to emphatically endorse this final statement made by Director May. Cane varieties in Porto Rico are "intolerably mixed". Nothing in connection with cane culture is more urgently needed than to get them separated again into pure cultures. Of the two hundred varieties bred at the Mayagüez Station from 1906 to 1910 all seem to have been lost in this general mixture. One of them P.R.-68, turned up in the mosaic-immunity tests at Santa Rita (see Bull. 19) but no trace of the others has been found.

The next definite information in our possession regarding importations of varieties is contained in the following letter addressed by Mr. Harold J. Sewall of Naguabo to Mr. H. B. Cowgill of this Station under date of April 26, 1915:

"Replying to your inquiry of the 16th ult.: I have received and brought in from Antigua, B. W. I., the following canes:

Introduced 1909:

Sealey Seedling, not here previously.
D-109, not here previously.
B-109, not here previously.
B-156, not here previously.
B-4596, not here previously.
B-208, already grown at Mayagüez.
B-147, already grown at Mayagüez.
B-306, already grown at Mayagüez (as B-347).
D-74, already grown at Mayagüez.
D-625, Grown at Canóvanas and Fajardo as D-116.

Introduced 1911:

B-1529, not here previously.
B-4507, not here previously.
B-6436, not here previously.
D-848, not here previously.
D-1111, not here previously.
St. Kitts Seedling, a sport of B-208, to which it reverts when grown here.

"The above canes were sent me by J. C. Waldron of Antigua, now returned to South Carolina, and I believe that the planters of this Island are greatly in Mr. Waldron's debt. At the time he shipped the first lot of canes he had never met me, but had corresponded with me on cultivation methods. Later I visited him in Antigua and brought back some important canes.

"With regard to the now famous Yellow Caledonia cane, I am glad to be able to throw light on its history here, but very sorry not to be able to claim its introduction. As early as 1906 Mr. D. W. May received this cane, I believe, from the Planters' Station in New Orleans, under the name of Rose Bamboo. In 1908 I got it from him, and on growing it discovered that it was not Rose Bamboo, which is the Hawaiian title for Cristalina, but the cane pictured in Noel Deerr's book as White Tanna. This in Hawaii is called Yellow Caledonia (see Eckert and Deerr's bulletins on cane nomenclature). This fact became apparent in the spring of 1909, when Mr. E. E. Olding received from his brother-in-law at Eva, Hawaii, a few cuttings of Yellow Caledonia which were turned over to me and planted close to the cane I had over a year previously gotten from Mr. May. Thereafter we called the cane Yellow Caledonia. Probably the report that Mr. Olding introduced the cane here sprung from his receipt of these cuttings.

"It is, of course, a fact that cuttings of this famous cane were also sent by Mr. May to other planters, but with the single exception of Guánica no one gave them any care or attention. Seedling work was begun at Guánica at about the same time that I took it up—1908—and they were practically alone in recognizing the value of the new canes. Mr. Marr at Canóvanas had gotten one or two canes from Demerara, notably the cane D-625 which caused so much trouble under the number D-116.

"To Mr. D. W. May belongs the credit of being the pioneer, and it is the fault of the planters themselves that they did not appreciate the value of the canes which he sent to quite a number of them. They did not, however; in fact, seedling canes were decidedly unpopular in 1908 and 1909.

"Yellow Caledonia is today grown everywhere in this section. There are hundreds and hundreds of acres of it in the San Cristóbal fields and both Fajardo and Borinquen are planting it as fast as they can get it. It has added close to five tons an acre to our yields hereabouts.

"Although I may not claim the credit of introducing Yellow Caledonia, I may without presumption insist that I made it stick. On my own lands and on the fields of the company where in the fall of 1909 I planted it in areas of some size, the cane made a phenomenal growth and gave a splendid appearance. In the mill it gave the average amount of sugar. It stood up well on poor soils and under neglect. Everybody wanted it by the planting season of 1911 and I sent cuttings to Aguirre and to Fajardo. All of the Yellow Caledonia in the east

end came directly or indirectly from this place. I don't know why it never survived in the west end, but it never did.''

This interesting letter is of great historical value, since it fixes the date of importation of many kinds and gives so vivid a picture of the first general planting of the Yellow Caledonia. It also illustrates the difficulty of interesting planters in new varieties except under the stress of some calamity that forces attention on this question.

About 1908 Central Guánica secured the services of Charles T. Murphy of Barbados and actively began the building up of a variety collection and the breeding of new seedlings. After the death of Mr. Murphy he was followed by Mr. H. Bourne, and he by Mr. E. H. Barrow, both from Barbados. It seems quite certain that Mr. Murphy brought with him a considerable number of Barbados canes. Many of them are mentioned in his reports for 1910, 1911 and 1912, copies of some of which are available in the files of this Station. Unfortunately, owing to changes in personnel and other factors, it has been impossible to secure exact data as to Guánica's importations.

In 1910 a considerable number of variety plots existed on the Carmen property of Central Aguirre. The seed mainly seems to have come from the Mayagüez Station. This planting was seen by the writer on his visit to the Island at that time. At the same time a much larger collection was seen at Central San Cristóbal, but this seems to have been Mr. Sewell's importation that has already been noted.

Mr. Sewell's letter calls attention to the direct importation of a few canes from Demerara by Mr. Marr of Central Canóvanas at some time prior to 1909. And it is known that Central Mercedita of Ponce made a direct importation from Barbados in 1911. of the following ten kinds (See 2nd. Ann. Rept., p. 11):

B-1809	B-6835
B-3750	B-7169
B-3859	B-7245
B-6293	B-8660
B-6341	Diamond-185

It succeeded in bringing in a few seeds of Badila and of D-1135 after their detention for nearly three years in quarantine in Washington. This completes the history of cane introductions in Porto Rico in so far as it has been possible to trace them. Central Fajardo maintains a large variety collection and has produced many new seedlings, but does not seem to have made direct importations.

DESCRIPTIONS AND DISCUSSIONS OF CANE VARIETIES IN PORTO RICO

From Mr. Earle's most excellent statement the idea and arrangement of the following varietal descriptions can be easily understood and little further explanation is necessary. The writer, in arranging the varieties, has followed a strictly alphabetical arrangement rather than dividing the canes discussed into the named varieties, the Barbados and Demerara seedlings, the Porto Rico seedlings, etc., although all varieties pertaining to any one group or section have been assembled under one general heading, such as the Java canes, including E. K. 28, Kassoer and the P.O.J.'s, the Chinese canes, under which come canes so widely separated alphabetically as Cayana and Zwinga, etc., etc. As an appendix a strictly alphabetical cross-index has been prepared, in which the reader will find page references to every variety herein discussed.

In the case of the varieties described by Mr. Earle, which represent about 35 per cent of the descriptions herein included, his descriptions, indicated by an asterisk in front of the name of the variety, have been retained practically *in toto,* only an occasional addendum having been made, and in some cases the larger part of the discussion of the cane's qualities has also been retained, although in most cases the economic status of the older varieties has so changed for the better or worse—usually the latter—in the past five years that most of the discussions have had to be entirely rewritten. With the exception of the Porto Rican seedlings, to which about the only references are to be found in literature published here and largely listed in the Bibliography in Appendix C, and of the Tucumán seedlings, of which little is definitely known as yet, the writer has included at the foot of the discussion of each kind a pair of pertinent references to that particular variety in the literature. His first intention was to prepare a general bibliography of the cane varieties herein treated, but, after working for several months in that direction, his bibliography had acquired such kilometric proportions that it was decided that the reader could much more readily encounter the references to the particular canes in which he happened to be interested if the most important of these were placed directly under these varieties, although Appendix C represents over 160 references to articles in regard to varieties today prominent in Porto Rico.

Technical descriptions and discussions are necessary evils at best and the writer has attempted to make this manual of more general interest than such works generally are to the average planter and amateur euthusiast in varietal work by preparing as many illustrations as possible of the more prominent canes today cultivated, not only in Porto Rico, but in the entire world. Around fifty of those varieties are illustrated in colors, while about an equal number are shown in half-tones. The author feels confident that a far larger proportion than otherwise of persons interested in cane varieties will compare their varieties with these descriptions if they have something more graphic to utilize than the mere technical descriptions, which by themselves are generally sufficiently dry to dessicate rather thoroughly the average person's budding interest in this most important phase of sugar-cane improvement.

In the following pages will be found such data as is now available concerning each of the two hundred or so more or less prominent varieties recorded as occurring in the "Isle of Enchantment".

PRINCIPAL CANE VARIETIES TESTED IN PORTO RICO

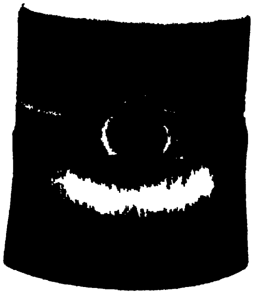
Badilla (New Guinea 15). See Plate 1, opposite page 85.

This is an old variety which has given most excellent results in the past decade in Mauritius, Reunion, Trinidad and Queensland, and more latterly in Hawaii. It is a dwarf type of cane, a splendid germinator, a fair stooler and a cane of early maturity and high sugar content and purity. It was imported by the Insular Experiment Station from Washington (Bureau of Plant Industry) in January 1921. It is highly resistant to Mosaic Disease, but takes the disease occasionally.

Erect, good vigor, a strong stooler, seldom flowers, stalks dwarf type, short and stout, blackish purple, scanty bloom. Internodes short, cylindrical, slightly enlarged at base, slightly staggered, furrow slight to none. Nodes even; growth ring broad and even, oblique, white to concolorous; root band broad, oblique, white to concolorous, rudimentary roots few and scattered, too to three in a row, purple; leaf scar glabrous, appressed behind; glaucous band constricted, broad and well defined. Buds orbicular, large, 12 by 16 mms., not exceeding growth ring, purple, margins, becoming uniformly purple with age, germination sub-dorsal, premature, margins rather narrow and abruptly shouldered at sides, glabrate, no basal placs. Leaf sheaths with scanty vestiture of short white hairs, sides glabrous, glaucous, purple, inner base heavily tinted with purple; throat wide, nearly glabrous; collar very wide, well defined and reaching midrib, lannate, with very short velvety hairs; ligule medium width, 3–5 mm.; slightly fiambrate; ligular process short, 1½ to 2 cms. on one side only Leaf blades spreading, erect tips, very wide, 11–13 cms., yellowish green, margins uniformly and minutely serrulated, very sparse basal ciliation.

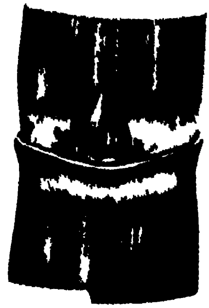
The Annual Report of the Reunion Experiment Station for 1912–13 reports a very good yield of this cane of 42 tons per *arpent* (40,000 sq. ft.) and an average yield from various fields of 24.7 tons per *arpent*. In one test in Mauritius this variety gave a sucrose content of 18.21 per cent in the juice and a purity of 94.1 per cent —a remarkable analysis. Trinidad Bull. 16 in 1917 reported Badilla as occupying first place in sugar produced per acre the previous year. Both Queensland and Hawaii have reported excellent results with this unusual looking variety and S. Asunción and M. Medina in the *Philippine Agricultural Review*, Vol. 18, pp. 107–23, report that

PLATE I



Badıla

B 39



B 67

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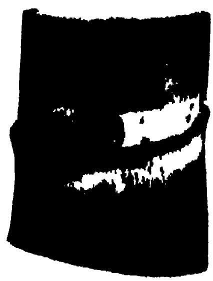

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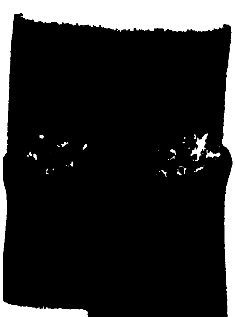
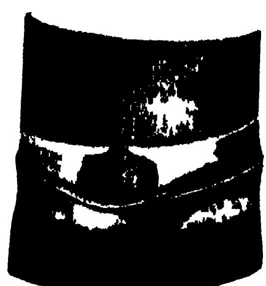


B. 154

B. 208



B 1030

"Badilla was found to be the best yielder of all the varieties tested, giving an average yield of 2.6 tons of sugar per acre in one test and over 4 tons in another. This production is more than twice that of the popular variety Negros Purple, the standard of comparison in all tests, which yielded under 1.2 tons. Badilla also has a better ratooning power than the others."

The following analyses have been made:

Location	Date	Age	Mill	Tons cane p. acre	Brix.	Sucr.	Purity	Tons sugar p. acre
Aguirre	XII 1-24....	16½ mth.	Hand	. . .	14 60	11.93	81.70	....
Aguirre	XII 15-24....	17 mth...	Hand.....	..	21.05	19.46	92 20	......
Exp. Sta..........	X 15-24....	1 year ...	Hand....	.	16 30	12.96	79.51	....
Exp. Sta..........	II 20-26.....	16 mth....	Cent. ...	38.50	19 59	17.99	92.60	5.25
B. H. 10 (12)	II 20-26......	16 mth....	Cent....	51 81	17.48	15 00	86 06	6.05
Hatillo Fruit Co...	V 14-26	16 mth....	Hand ..	......	22 40	20.93	93 48	....
B. H. 10 (12)	V 14-26....	16 mth....	Hand..	. .. .	18.85	16.80	89.12	....

In the tonnage comparison with B.H. 10(12), Badilla was planted with fifteen others of the most promising canes at the Station and stood first amongst all these in Brix, Sucrose, Purity and, therefore, factor of recovery. In production of sugar per acre it stood third. Well worth further trial, particularly on the north-coast hill lands.

OTHER REFERENCES

EASTERBY, H. T.—Twenty-Third Annual Report of the Queensland Bureau of Sugar Experiment Stations for 1923.

ROSENFELD, ARTHUR H.—Annual Report of the Special Technologist for Cane. Annl. Rept. of the Ins. Expt. Sta. of Porto Rico, 1923–24, pp. 62–8.

Bambú Blanca.

An old variety abundantly mixed with Otaheite, Penang, Rayada and Cavengerie in most of the cane fields of the north coast, not seen in pure cultures. Country of origin and time of importation not known.

Erect, of good vigor, medium stooling, sometimes arrows, stalks of medium diameter, 3 to 3¼ cm., green, no flush and no bloom. Internodes straight, cylindrical, medium length, furrow slight and poorly marked. Nodes prominent, slightly larger than the internode; growth ring narrow 1 to 1½ mm., not swollen, concolorous; root band slightly enlarged, about 10 mm. wide, paler than the internode; rudimentary roots crowded, swollen, yellowish, the centers dark, in 4 rows; leaf scar glabrous, slightly oblique, appressed behind; glaucous band 8 to 10 mm. wide, conspicuous, not constricted. Bud ovate, acute, about 10 × 12 mm. at first not exceeding growth ring

but often enlarged later, margin medium width, uniform, germination subapical, base, sides and apex sparingly hirsute. Leaf sheaths with a dense vestiture of conspicuous erect whitish hairs, somewhat glaucous, green, not tinted; throat lannate and with an abundant vestiture of long hairs; collar broad, conspicuous, reaching the midrib, densely glaucous but not lannate, ligule short about 3 mm., margin nearly even; ligular processes none or poorly developed. Leaf blade flat, suberect with declined tips, 6 to 7 cm. broad, dark green, serrulations very minute, the margins at base ciliate.

A variant with white stripes in the leaves is not uncommon.

No chemical data are available.

Its general vigor, comparative freedom from root disease and adaptability to varied soil conditions are sufficiently proven by its persistence as an important element in so many mixed cultures. Its ripening period, sugar production and adaptability to special conditions should be more fully tested. It is, however, quite susceptible to mosaic and to the gum disease.

The cane described on another page as Penang is often found growing with this one and may easily be confused with it. It can be distinglished by the obtuse, more nearly glabrate buds, by the broader, swollen growth ring and by the lilac tint of the leaf sheaths.

Another unknown cane found in these mixed plantings superficially resembles this one but has suborbicular buds and nearly glaucous leaf sheaths.

The white Bamboo mentioned by Mr. May as introduced from the Audubon Station, Lousiana, in 1904 has not been traced. Mr. Crawley, the former Director of this Station, in a manuscript note records seeing this cane at Añasco and that it had a conspicuous wine-colored stain on the inside of the leaf sheath at the base as in Yellow Caledonia This shows it could not be the cane under discussion.

Bambú Rayada.

This name may be given to a variant of the above, having white stripes on the stalks and leaf sheaths which is occasionally found growing with the typical form (planted as X–25).

Bambú Rosada.

Mentioned by Dr. Stahl (p. 136), who says:

"A beautiful rose colored cane which easily loses its color with age and bad cultivation. It can compete with the Caña Blanca."

It seems to be the same cane mentioned by López Tuero (p. 9) under caña Bambú. He describes it as rose-colored when young,

but later yellowish; says it is very stout, vigorous and resistant but hard and low in sugar; advises planting it on the outside rows of the fields.

The cane has not been traced.

The Rose Bamboo imported from Louisiana in 1904 (see letter of Mr. May, p. 79 proved to be Yellow Caledonia (see letter of Mr. Sewall, p. 79.

Bambú Rosada de Rayas Moradas.

Listed by Stahl (p. 136), but without description. No other references found. Probably only another name for Rayada.

The Barbados Seedlings.

Of the vast number of seedlings bred by Mr. J. R. Bovell in Barbados only a comparatively small number of these have reached Porto Rico. Most of these belong to the earlier series that was designated simply by the initial B. All of these older varieties that we have here are good canes but none of them have proved to be superlatively good. Most of them have been rather widely disseminated but only a few have been planted on a large scale. Such facts as have been gathered concerning each of them will be found below, including some data on the famous BH 10(12), our most widely planted variety in Porto Rico today. This remarkable general-purpose cane comes under the heading of "Hybrids" in the Barbados classification, *i. e.*, it is a seedling of known parentage, obtained by emasculating flowers of good variety before the anthers open, bagging them to prevent promiscuous pollination and pollinating them with pollen of the male parent which has also been bagged to prevent contamination by unknown wind-borne pollen. A later series of ordinary seedlings are given the letters Ba, while the letters B.S.F. signify self-fertilized seedlings, obtained by bagging some of the better varieties before the anthers open so as to ensure that they are not cross-fertilized.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Seedlings Canes and Manurial Experiments for the Season 1909–1911. Barbados.
Idem.—*Ibid,* 1911–13.

B-39. See Plate I, opposite page 85.

Obtained in November, 1924, from Hon. John R. Bovell, Director of Agriculture in Barbados and producer of this variety.

Erect, at length recumbent, good vigor. Stalks long, medium girth, green turning yellowish with age, no bloom, long, parallel,

striations. Internodes long, almost cylindrical, enlarged and shouldered opposite bud, distinctly staggered, broad, shallow, cicatrized furrow. Nodes slightly constricted, oblique; growth ring broad and prominent, especially at back opposite bud, green to greenish brown; root band broad, oblique, yellow to green; rudimentary roots large, conspicuous, few and scattered 3–4 in rows, purplish brown; leaf scar glabrate and appressed behind; glaucous band constricted, broad and conspicuous. Buds lanceolate, large, swollen, 10–12 mm., exceeding growth ring by one-third, germination apical, margins of medium width and on upper half only, glabrate, no apical tufts, heavy basal placs. Leaf sheaths with heavy dorsal vestiture of long tawny hairs, glaucous, heavily tinted; throat broad and well defined, glabrate except for sparse straggling hairs at margins; collar wide, reaching midrib, glaucous; ligule narrow, enlarged at center, nearly even; stubby trace of ligular process on one side only. Leaf blades spreading, with declining tips, medium width, about 6 cms., dark green, very minutely serrulated.

Planted out in tonnage experiments in fall of 1925. No data available as yet.

REFERENCES

D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1923–25. Barbados Dept. Agr. 1926.
BOVELL, J. R., AND D'ALBUQUERQUE, J. P. *Idem,* 1922–24.

B-67. See Plate I, opposite page 85.

Also obtained from Hon. John R. Bovell, Barbados in 1922

Erect, at length recumbent, fair vigor. Stalks long and medium girth, yellow, heavy flush, some bloom, discolored white striations and irregular blotches; internode medium to long, cylindrical, staggered, furrow traces to none. Nodes slightly constricted and oblique; growth ring broad and elevated, parallel, brownish to concolorous; root-band wide, oblique, concolorous, rudimentary roots fairly crowded and inconspicuous, 3 to 4 in a row, concolorous; leaf-scar glabrous, appressed behind; glaucous-band slightly constricted, broad and fairly well defined. Buds lanceolate, large, 12–16 mm., exceeding growth ring by one third to one half, germination sub-apical and premature, margins broad and flat, nearly glabrous, with a few very short hairs near tip, basal placs with long coarse hairs. Leaf-sheaths lannated at back with short tawny hairs, sides glabrous, glaucous, light yellow to green color, inner base slightly tinted with purple; throat broad and yellowish; collar broad and angular, glaucous, reaching mid-rib; ligule narrow 2 to 4 mm., nearly even; ligular process broad and blunt, 1–2 cms., on one side only. Leaf blades

spreading with declining tips, medium width about 6 cms., yellowish green, margins minutely but uniformly serrulated, sparse ciliation at base.

This fine-looking cane has made an excellent record in Barbados, but with us has proved a consistently poor germinater and a poor ratooner. The writer wrote the producer of this cane, Hon. Jno. R. Bovell, in regard to the poor germination of this variety and in a letter dated March 12th, 1925, Mr. Bovell said:

'B 67 is too new a cane yet to say definitely what the germination is, but at the present time it is fairly good.''

Planted at the Station in 1922 alongside B.H. 10(12), it never made growth as plant to compare with the latter and, while stooling fairly well as first ratoons, B.H. 10(12) was consistently of better appearance throughout the season. As second ratoons the B 67 practically disappeared, while the B.H. 10(12) alongside gave an excellent yield and is now growing vigorously as third ratoon. The B 67 is characterized by its very light-colored foliage.

The following analyses have been made at the Station:

Date	Age	Mill	Tns cane per acre	Brix	Sucr	Purity	Tns sugar per acre
XI 7 24	11 months	Hand		13 90	10 16	75 25	
XII 9 24	12 months	Hand		15 70	12 59	80 19	
I I 25	13 months	Hand		16 14	13 51	83 71	
II 8 26	16 months	Cont	28 60	18 50	16 72	91 10	3 61
BH 10 (12)	16 months	Cont	51 81	17 43	15 00	86 06	6 05

In the tonnage experiment with B H. 10(12), for which figures are given above, B-67 stood second in sucrose and third in purity amongst sixteen kinds, but was thirteenth in production of sugar per acre. Hardly seems likely to compete with B.H. 10(12) successfully in Porto Rico, as it appears to be a more delicate cane in every sense.

REFERENCES

MENÉNDEZ RAMOS, R.—Annl. Rep. of Ins. Expt. Sta. of P. R, 1922–23.

ROSENFELD, ARTHUR H.—Rept. of the Spec. Technologist. *Idem*, 1924–1925.

B-88.

A cane under this name was found growing at Río Grande, by Earle. There is no record of the introduction of this kind. Its identity has not been determined.

well defined, reaching midrib, lannate; ligule narrow except at center, nearly even, no ligular process. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, minutely and uniformly serrulated, scanty basal ciliation.

Planted out in tonnage experiments in fall of 1925. No data available as yet on behavior in Porto Rico.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts, for the Season between 1921–23. Barbados Dept. Agr.

ROSENFELD, ARTHUR H.—Report of the Special Technologist for Cane. Annl. Rept. of the Insular Expt. Sta. of P. R., 1924–25.

B–119. See Plate 1, opposite page 85.

Kindly brought from Barbados in November, 1924, by Director of Agriculutral Extension Otis W. Barrett, at the request of Commissioner of Agriculture Carlos E. Chardón.

Erect at length recumbent, fine vigor, good stooler. Stalks long, medium girth, green to yellow. Internodes long, slightly tumid, staggered; furrow traces to none. Nodes constricted, oblique; growth ring broad and prominent, green to yellowish brown; root bands wide, oblique and concolorous; rudimentary roots few, small and scattered, 3–4 in rows, brownish; leaf scar lannate, appressed behind; glaucous band broad, conspicuous and constricted. Buds, medium size, 8 × 10 mm., just exceeding growth ring, ovate, germination subapical, margins flat, narrow and on upper half only, glabrate, very light basal places. Leaf sheaths with abundant dorsal vestiture of short, tawny, deciduous hairs, slightly tinted, inner base green; throat broad and well defined, covered with abundant vestiture of long coarse hairs; collar broad and well defined, reaching midrib, lannate; ligule very narrow, although slightly broader at center, nearly even; no ligular process. Leaf blades plicate, medium width, about 6 cms., dark green, with very prominent broad, white midrib, margins very minutely serrulated, sparse basal ciliation.

Planted out in tonnage experiments in fall of 1925. No data available as yet on behavior in Porto Rico, although its general appearance is superior to B.H. 10(12) in above-mentioned tonnage experiments.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts, for the Season between 1921–23. Barbados Dept. Agr.

ROSENFELD, ARTHUR H.—Report of the Special Technologist for Cane. Annl. Rept. of the Insular Expt. Sta. of P. R., 1924–25.

B-147. See Plate 1, opposite page 84.

Introduced from Antigua in 1909 by Mr. Sewall, but he remarks that it was previously grown at Mayagüez. He notes that it is good as both plant and ratoon but that it is hard to establish. In November, 1910, Mr. Murphy notes that it was growing slowly at Guánica, and in January, 1913, that it had been abandoned as it did not seem to succeed. Not seen by Earle. Early in 1925 it was brought to the Station from San Lorenzo, to where it had been imported from St. Croix recently by Assistant Agronomist Luis Serrano. It is now being grown for extension and study at the Station.

Hon. H. H. Cousins, Director of Agriculture in Jamaica, wrote of this variety in 1910:

> "This cane showed up best at Long Pond Estate. One of the peculiar characteristics . . . . is that prolonged drouth seems to have no effect on its growth after it has once started to point. At first it is rather disappointing, as it comes up very slowly and with yellowish leaves, but to those who know the cane this is one of its natural features."

Mr. F. W. South, in reporting on the prevalence of disease in the West Indies in 1909–10 says that B–147 was always more subject to attacks of rind disease than any other variety. It is highly susceptible to Mosaic Disease.

Erect, fair vigor, stalks long, good girth, green to bright yellow, slight bloom, no flush. Internodes long, cylindrical, not staggered, furrow distinct for three-fourths the length of the internode, narrow, shallow and dark brown. Nodes constricted, oblique, growth ring medium width, even, green to concolorous; root-band wide, rather inconspicuous, oblique, concolorous; rudimentary roots small, crowded, inconspicuous 4–5 in a row, purplish to concolorous; leaf scar glabrate and appressed behind; glaucous band broad, conspicuous and constricted. Buds small, 8 × 10 mm., flat, scarcely exceeding growth ring, ovate, germination apical, margins flat and narrow, abruptly shouldered at base, distinct apical tuft, heavy basal placs. Leaf sheaths with scanty dorsal vestiture, sides glabrate, light green, glaucous; inner base very slightly tinted with purple; throat broad, very sparse lannation, long and straggling marginal hairs; collar broad and well defined, reaching midrib, glaucous, ligule narrow, 2–4 mm, nearly even; ligular process very short and on one side only. Leaf blades spreading with declining tips, medium width, about 6 cms., light green, upper two-thirds of margins minutely serrulated, very sparsely ciliated at base.

REFERENCES

COUSINS, H. H.—Bull. Dept. of Agr. of Jamaica, Vol. I, No. 2, 1910.
SOUTH, F. W.—A Report on the Prevalence of Some Pests & Diseases in the West Indies for the year 1909–10. West Indian Bulletin, XI, 2, pp. 74–5.

B-154. See Plate I, opposite page 85.

Also brought from Barbados in November, 1924, by Mr. O. W. Barrett. Planted out in tonnage experiments only in fall of 1925, hence there are no data as to its behavior in Porto Rico.

Erect, at length recumbent, good vigor. Stalks long, medium girth, green, through yellowish brown to red, with light colored, wavy striations on upper halves of internodes. Internodes long, cylindrical, very slightly staggered, furrow long, broad and shallow. Nodes slightly constricted, oblique; growth ring narrow and prominent, light green to reddish brown; root band medium width, parallel, green; rudimentary roots large, conspicuous, few and scattered, red; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and conspicuous. Bud large, 10 × 12 mm., exceeding growth ring by one-third to one-half, ovate, germination apical, margin broad, flat and on upper half only, distinct lannation along fibro-vascular bundles of buds, no apical tufts, heavy basal placs. Leaf sheaths lannate dorsally, sides glabrate, glaucous, slightly tinted; inner base green; throat broad and well defined, brownish, glabrate; collar broad and reaching midrib, glaucous; ligule narrow at sides; short stubby ligular process on one side only. Leaf blades spreading with declining tips, dark, green, broad, 8–10 cms., margins uniformly and minutely serrulated to base, sparse basal ciliation.

REFERENCES

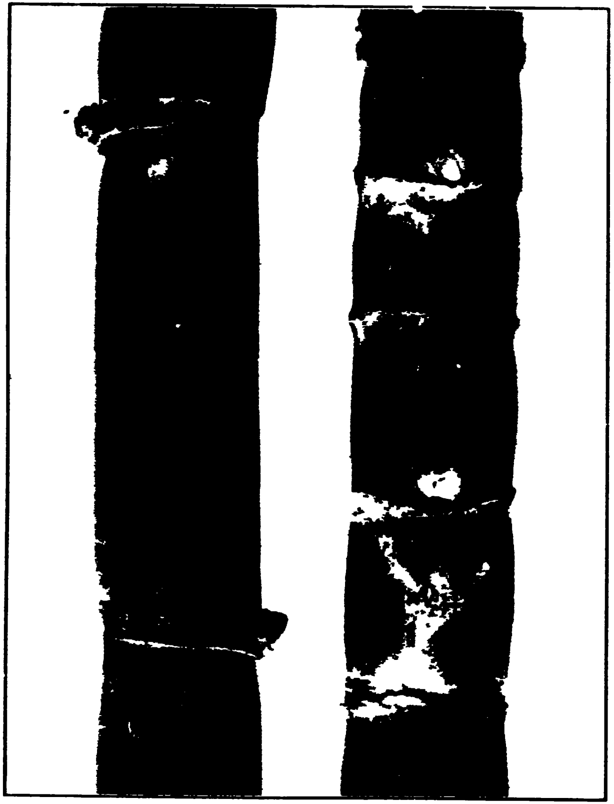
BOVELL, J. R. & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1920–22. Barbados Dept. Agr.
Idem.—1921–1923.

B-156.

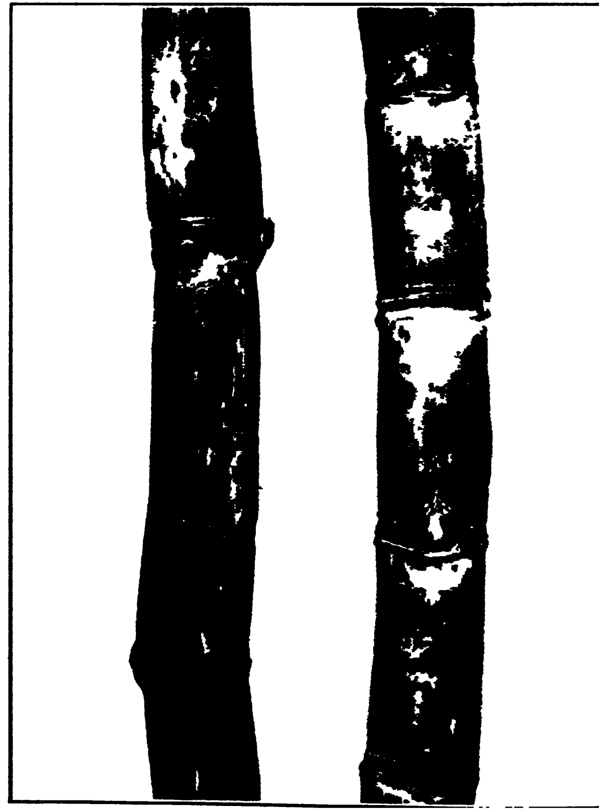
Introduced from Antigua in 1909 by Mr. Sewall. He notes that it was easy to establish and was rich in sugar but not heavy in tonnage. It does not seem to have been planted elsewhere. Not seen.

* **B-208.** See Plate I, opposite page 85; also Plate VII, opposite page 95.

Parentage unknown. Introduced from Antigua by Sewall in 1909,



B 208



B 306

but he notes that it had been previously grown at Mayagüez. A large field of it in good condition was noted at Central Fortuna by Mr. Crawley in August, 1910. Included by Murphy in a list of best canes from Guánica, December, 28, 1910. Mentioned by McConnie among the best canes for Fajardo, June 24, 1913. Frequently seen in all parts of the Island but particularly on the south and east coasts, where considerable fields of it are still cultivated.

Erect or at length declined, vigorous, medium stooling, seldom arrows. Stalks medium length, medium stout to stout, green, usually no flush, somewhat glaucous. Internodes short, tumid, usually abruptly enlarged below at the back, furrow evident but shallow. Nodes narrow, strongly constricted; growth ring narrow, at first yellow then concolorous and inconspicuous; root band narrow, oblique 5 to 8 mm., leaf scar glabrous; glaucous band narrow, strongly constricted, well defined. Buds subhemespheric but broader than long, about 12 × 10 mm., not exceeding the growth ring, margin narrow but distinctly shouldered, germination subdorsal, soon developing on the standing stalk, with a scanty apical tuft of long hairs. Leaf sheaths with a dense vestiture of long erect pallid hairs, green or somewhat tinted, rather glaucous, stained with purple at base within; throat lannate, and with an abundant vestiture of long hairs; collar conspicuous, reaching the midrib, the center densely glaucous, the margins lannate with short white hairs; ligule medium width, about 8 mm., edge fimbriate; ligular processes usually none. Leaf blades, semi-erect, not numerous, broad, reaching 8 to 9 cm., rather short and abruptly pointed, sharply serrulate, the base a little ciliate.

This was the first of the Barbados seedlings to attract wide-spread attention. It has been carried all over the world and has been tested wherever cane is grown on a commercial scale. At times it gives splendid results both in tonnage and sucrose, but its behavior has been too uneven to be fully satisfactory. It is by no means a general-purpose cane, being confined to a rather narrow range of soil conditions. It requires a rich, moist but porous and well-drained soil. In fact its requirements are much the same as those of the Otaheite but it is even more intolerant of drouth. In Porto Rico it does well on semi-*poyals* and alluvial *vegas*, especially where irrigation is available. In such localities it ratoons much better than Otaheite an it is to be strongly recommended, especially for late spring planting, since it matures fairly early. It is not adapted to hard, dry, exhausted soils.

On suitable soils it is fairly resistant to root disease, as shown by its good ratooning power, but it is very susceptible to mosaic,

taking the disease easily and suffering seriously when attacked. It is, too, somewhat susceptible to the gum disease and should not be planted where that is prevalent.

Its great reputation for unusual sweetness is hardly sustained by our records. With all of the conditions fully favorable it will doubtless sometimes exceed Cristalina in the per cent of sucrose, but as seen from the following selected analyses it frequently falls below that standard kind when taken under comparable conditions:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B 208	Feb 1912	Pl		17 1	13 9	1 2	81 3	.
B 208	Feb 1918	Rat		19 95	18 68		93 6	
B 208 (1).	2 12-18	Pl		17 3	14 71		85 02	.
B 208 (2)	1 5-20	Rat 14 mo	66 4	18 98	16 99		89 50	
B 208	12-6-20	Rat 13 mo	62 7	15 0	12 07	1 99	84 66	10 27
Average of 5 Cheribon canes	12-6-20	Rat 13 mo			13 69	1 67	85 88	12 29
B 208	12-15-20	Rat 14 mo	70 1	18 15	15 87	0 89	87 43	9 56
Cristalina	12-15-20	Rat 14 mo	70 0	17 50	15 33	0 28	87 50	9 68
B 208	1-24-21	Rat 15 mo	62 9	17 70	15 05	0 85	87 50	11 85
Cristalina	1 24-21	Rat 15 mo	70 8	17 85	16 14	0 83	90 42	10 69
B 208	2-9-21	Pl 16 mo	64 0	18 00	15 78	1 08	87 22	11 52
Cristalina .	2-9-21	Pl 16 mo	68 7	16 20	13 85	0 95	85 49	11 20
B 208 (3)	Apr 1918	Pl			18 08		93 6	
B 208 (4)	3-18-11	(Sewall Naguabo)		22 40	22 0		98 20	
B 208	Mar 1912	(Guánica Reports)		18 6	15 7		81 9	
Otaheite	Mar 1912	(Guánica Reports)		17 3	14 3		79 7	
B 208	Mar 1912	(Guánica Reports)		18 2	15 2		81 4	
Otaheite	Mar 1912	(Guánica Reports)		17 7	14 9		82 2	
B 208	Mar 1913	(Guánica Reports)		20 4	16 6		81 4	
Otaheite ...	Mar 1913	(Guánica Reports)		18 7	14 9		79 8	
B 876	Mar 1913	Guánica Reports)		19 4	16 1		82 8	
B 208	Feb 1926	Ins Sta Tonnage Expt		12 58	16 09	Cane 84 44 Ins	92 50	Sug p A. 4 22 Ton.
B H 10 (12)	Feb 1926	Ins Sta Tonnage Expt		17 43	15 00	Cane 54 81 Ins	86 06	Sug p A. 6 05 Ton.

(1) Was seventh in sucrose in a lot of 20 kinds

(2) Was fifth in sucrose out of 37 kinds Cristalina average of 9 plots 17 27 per cent; B-376 18 18 per cent B-1809 17 42 per cent PR-208 17 51 per cent

(3) Highest for the year in sucrose—Cowgill

(4) The highest analysis found in our records for any cane

This once favorite variety seems in Porto Rico to have more than met its match in B H 10(12) and even at Mercedita de Ponce, its former stronghold, it has now been almost entirely replaced by its younger and more adaptable relative

REFERENCES

Blouin, R E.—Variedades de Caña Rev Ind y Agr de Tucumán, IV, 5:1913.

Rosenfeld, Arthur H—The B.H. 10(12) and S.C. 12/4 Canes in Porto Rico Jour of the P R Dept Agr. IX, 3, pp. 215-47; July, 1925

B-268.

Also brought from Barbados in November, 1924, by Mr O W.

Barrett. Planted out in tonnage experiments only in fall of 1925, hence there are no data as to its behavior in Porto Rico.

Recumbent, good vigor. Stalks long, good girth, yellowish green base overlaid with heavy violet bloom, red flush on exposure to sun. Internodes medium length, decidedly tumid and pronouncedly enlarged at base, staggered, furrow broad, shallow and well defined. Nodes very conspicuous and oblique; growth ring wide, even, brown changing to green; root band medium to wide, oblique, light green to concolorous; rudimentary roots inconspicuous, few and scattered, 3–4 in rows, purplish to brown; leaf scar glabrate, appressed behind; glaucous band inconspicuous, broad and deeply sunken. Buds large and flat, 12 × 16 mms., exceeding growth ring by one-half, lanceolate, germination apical, margins narrow and glabrate, on upper two-thirds only, no apical tufts; light basal placs. Leaf sheaths with extremely sparse dorsal vestiture, sides glabrate; glaucous, tinted, inner base green; throat broad and sparsely lannated, marginal tufts of long straggling hairs; collar wide, glaucous and reaching midrib; ligule medium width, convex at center, ligular process broad, 2–3 cms. long, on one side only. Leaf blades plicate with declining tips, medium width, about 6 cms., dark green, margins uniformly but very minutely serrulated, very sparse basal ciliation.

REFERENCES

BOVELL, J. R. & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1920–22. Barbados Dept. Agr.
Idem.—1921–23.

B-306. See Plate VII, opposite page 95.

Introduced from Antigua in 1909 by Sewall, who remarks "already grown at Mayagüez as No. 347". It seems to have been grown on the Station grounds as B-306 up to 1913, since that date it has been called B-347. It has been impossible to determine which is really the correct name for this cane.[1]

* **B-347.** See Plate VIII, opposite page 99.

Parentage unknown. Introduced from Audubon Park, Louisiana, by D. W. May in 1904. Reintroduced by Mr. Sewall (see above) as B-306. Frequently seen in mixed cultures, especially on the south and east coasts. It is occasionally found in the fields at Central Fortuna.

[1] Brief notes in Proc Agric Soc Trinidad, Tab 9: 108, 1909, indicate that B-306 is a yellow cane not unlike Otaheite while B-347 is called a dingy purple cane of heavy growth If this is correct, our cane is B-306 and not B-347

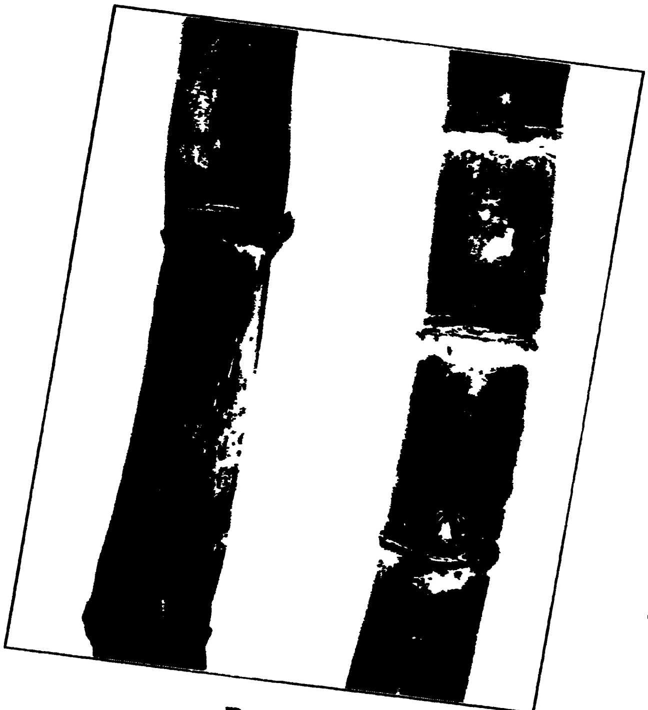
Erect or at length decumbent, good vigor, medium stooling, arrows occasionally. Stalks long, medium diameter, green, yellow on maturity, no flush, little or no bloom. Internodes medium to long, slightly flattened, strongly staggered, often marked with whitish blotches, furrow slight or sometimes none. Nodes slightly constricted; growth ring narrow slightly sunken, concolorous; root band strongly oblique, 6 to 10 mm., concolorous; rudimentary roots large but inconspicuous, concolorous, in about 3 rows; leaf scar at first conspicuously ciliate, later often glabrate, prominent, not appressed behind; glaucous band broad, well marked. Buds large, oval, obtuse, often reddish, 10 to 12 × 15 mm., margin uniform rather wide, usually exceeding the growth ring, germination subapical, basal place and apical tuft and lines of hairs on the sides. Leaf sheaths with a dense vestiture of pallid hairs, green or very slightly tinted, somewhat glaucous, slightly stained, with purple at base within; throat dark brown, densely lannate and with a circle of short dark hairs behind the ligule; collar dark, rather broad, reaching the midrib, lannate; ligule medium width, about 3 mm., margin even; ligular processes none. Leaf blades numerous, somewhat two-ranked, strictly erect, plicate and revolute, bright green, 7 to 8 cm., wide, very minutely serrulate, the base even, not ciliate.

This is a thoroughly good, medium-season, general purpose cane. It perhaps has nothing to specifically recommend it in preference to Cristalina and Rayada, though on some soils it will certainly outyield these kinds and will probably ratoon longer. It prefers moist rather than dry land. When immature it has less sugar than Cristalina in the same condition, but when fully ripe it is equally as good. It is a soft cane and is often badly damaged by rats. It may be planted either in fall or spring.

It resists root disease better than Cristalina. It is probably susceptible to mosaic but it was accidentally omitted from the immunity test at Santa Rita and we have no positive observations.

Neither has its reaction to gum disease been tested.

Kind	Date	Age	Arrows	Extr	Brix	Sucr	R. S	Purity	Fiber
B-847	12-28 20	Rat 9 mo	No	74 08	14 89	12 08	2.12	80.77	8 12
B-847	12-28-20	Rat 9 mo	Yes.	72.7	17 09	14 81	1 49	86.65	8.78
B-847	12-10-20	Rat 10 mo	No	71 7	13 98	10 87	2 98	74 44	7 77
Rayada	12-10-20	Rat. 10 mo	No	71 1	15.88	13 45	1.76	84.98	8.08
B-847	1-5-21	Pl 15 mo	No	71 1	16.96	14 90	1 13	87.85	11 56
Cristalina	1-5-21	Pl. 15 mo	No	66 6	16 96	15 35	0 56	90.56	11.25
B-847	2-9-21	Pl. 16 mo	No.	62 9	18.50	16 90	0 68	91 35	11.67
Cristalina	2-9-21	Pl. 16 mo	No.	68.7	16 20	13 85	0 95	85.49	11.20
B-847	1-25-22	Rat. 15 mo	No	66 7	19 05	17 30	0.32	90.81	11.26
B-847	1-26-22	Rat 15 mo	Yes	71.1	18 05	15 55	0.67	87 61	12.27
Cristalina	1-26-22	Rat. 15 mo	No	70.3	17 85	16.14	0.38	90.42	10.69


B 347


B 376

This cane was included in the Aguirre test plots in 1911 when it gave tons cane, 61.878; brix, 17.33; sucrose, 13.95; purity, 80.5; tons sugar, 6.08.

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COLÓN, E. D.—Varieties of Sugar Cane. Annl. Rept. of the P. R. Ins. Expt. Sta., 1917–18, pp. 22–4; San Juan, 1919.

VEVE, R. A.—Our experience with Cane Varieties. Memoirs Assn. Sugar Technologists of P. R., I, 1, pp. 28–31; June, 1922.

* **B-376.** See Plate VIII, opposite page 99.

Parentage unknown. Seems to have been introduced by Mr. Murphy from Barbados. It is mentioned in his reports under date of November, 1910, and in October, 1911, he reports 10 to 12 acres of it under cultivation at Central Guánica. At Central Fajardo 91 acres of it were harvested in 1917, and 66 acres in 1919. Fortuna still has a few fields of this variety. The writer found scattered plantings of it in Peru in the spring of 1926. There it seemed more resistant to alkaline concentration than Cristalina, to which it is similar.

The description of Cristalina will fit this cane word for word except that in B-376 the collar is glaucous or very slightly lannate on the extreme margins while, in Cristalina it is lannate throughout.

In cultural characters also it is almost the exact equivalent of Cristalina, though usually seeming a little more vigorous and often giving rather heavier tonnage. In one of the Fajardo reports it is noted as doing well on salty *poyals*.

In its behavior toward root disease and mosaic it is exactly equal to Cristalina. Its reaction to gum disease has not been determined, but doubtless like Cristalina it will be more or less susceptible.

As seen from the following selected analyses, it is the equivalent of Cristalina as a sugar producer. In fact, for all practical purposes it may be considered as a rather unusually vigorous strain of that standard kind and as such it has a very considerable value.

Kind	Date	Age	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
B-376(1)	1-5-20	Rat 15 mo.	68 0	20 05	18.18	....	90.4	....
B-376	12-28-20	Rat. 9 mo.	68 0	16 83	14.67	1.04	88.1	8.98
B-376	12-20-12	Rat. 14 mo.	70 5	16 43	14.67	0.35	89.4	10.58
Cristalina	12-20-12	Rat. 14 mo.	70 0	17.50	15.53	0.28	88.2	9.60
B-376	1-26-21	Rat. 15 mo.	64 2	16.65	15.21	0.59	91.3	11.45
Cristalina	1-26-21	Rat. 15 mo.	70 3	17 85	16 14	0 33	90 4	10.69
B-376	12-24-20	Pl. 15 mo.	68 6	18.48	17.0	0.37	91 9	10.19
Cristalina	12-24-20	Pl. 15 mo.	65.7	18.88	17.08	0.52	90.6	13.72
B-376	2-7-21	Pl. 16 mo	60.7	19.10	16.99	0 36	88.9	11.79
Cristalina	2-7-21	Pl. 16 mo.	68.6	17.90	16.14	0 80	90.1	12.61

(1) The highest in sucrose out of 37 kinds. Cristalina average, 3 plots, 17.27; highest, 18.10.

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CRAWLEY, J. T.—Second Annual Report of the Experiment Station for the Year 1911–12. Sugar Producers' Assn. of Porto Rico; 1912.

GOSSET, B. S.—Notes on the Sugar-Cane Experiments in British Guiana. Bull of the Dept. of Agriculture of Jamaica, II, 7, New Ser., pp. 207–218; 1913.

B-381.

Obtained from Barbados in November, 1924, through courtesy of Hon. Jno. R. Bovell, Director of Agriculture, who produced the variety. Was planted out in tonnage experiments at the Station only in fall of 1925, hence there are no data on its behavior on this Island, although its general appearance in above-mentioned tonnage experiments is inferior to that of B.H. 10(12).

Erect, at length recumbent, good vigor, fine stooler. Stalks long and stout, green changing to uniform brownish yellow, numerous light vertical striations on upper halves of internodes, slight flush, no bloom, tendency to split. Internodes long, cylindrical, staggered, furrow trace to none. Nodes nearly even and parallel; growth ring broad and prominent brownish to concolorous; root band narrow; light green to concolorous; rudimentary roots small and crowded, 3–4 in rows, brownish; leaf scar glabrate, appressed behind; glaucous band broad and conspicuous, constricted. Buds medium size, and plump 7 × 9 mm., germination subapical, orbicular, margins on upper half only, narrow at sides and broadening to apex, purple, sparsely lannated, with very wide and heavy apical tufts, light basal placs. Leaf sheaths with light dorsal vestiture, sides glabrate, glaucous, tinted, inner base lightly tinted; throat medium width, with dark waxy covering, no lannation except for a few coarse hairs at margins; collar narrow, reaching midrib, glaucous; ligule narrow and convex at center, ligular process none. Leaf blades spreading with declining tips, wide, 10–12 cms., dark green, uniformly and minutely serrulated and ciliated at margins.

REFERENCES

BOVELL, J. R., AND D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1919–21. Barbados Dept. Agr.
Idem.—1920–22.

B-417.

Obtained from Barbados in November, 1924, through the courtesy of Director of Agriculture John R. Bovell, the producer of the variety, who wrote us on July 21st, 1925, in regard to this variety,

that it is "not only . . . a heavy yielder, but it contains juice of high sucrose content and is a drought resister." It was planted out in tonnage experiments in October, 1925, and has consistently maintained a better appearance and more vigorous growth than B.H. 10(12), the check in all these experiments.

Erect, good vigor. Stalks long and robust, yellowish green at first, changing to uniform reddish purple, with long, thin, yellow vertical striations, some bloom. Internodes long, cylindrical, not staggered, no furrow. Nodes nearly even, oblique; growth ring indistinct, narrow and slightly elevated, light green to concolorous, root band wide, oblique, light green to concolorous; rudimentary roots small and crowded, 5–6 in rows, purplish to concolorous, marked tendency to premature sprouting; leaf scar glabrate, appressed behind; glaucous band medium width, slightly constricted and very inconspicuous on older joints. Bud small, 6 × 8 mms., reaching growth ring, orbicular, germination subdorsal, margins broad and flat at sides, becoming convex at center, lannated along fibro-vascular bundles and margins, apparently deciduous apical tufts, heavy basal placs. Leaf sheaths with sparse dorsal vestiture of short, tawny hairs, sides glabrate, some wax, tinted, inner base green; throat wide, lannated, a few straggling hairs at margins; collar broad and well defined, reaching midrib, glaucous; ligule narrow except at center, nearly even, ligular process on one side only, short and stubby. Leaf blades spreading with declining tips, broad, 10–12 cms., dark green, minutely and uniformly serrulated and ciliated at margins.

REFERENCES

Bovell, J. R., and D'Albuquerque, J. P.—Rept. on the Sugar-Cane Expts. between 1919–21.—Barbados Dept. Agriculture.
Idem.—1920–22.

B-425.

Another of the canes imported from Barbados in November, 1924, and the one which has shown up about the poorest of this lot of fifteen varieties, being the one outstanding kind suffering severely from attacks of *Helminthosporium sacchari*. Planted out in tonnage experiments in October, 1925, there has been as yet no time to obtain definite data as to its yield and sugar content.

Erect, fairly vigorous. Stalks long and of good girth, yellowish green, some flush, no bloom. Internodes of medium length, rather cylindrical, distinctly staggered, furrow short and shallow to none. Nodes even oblique; growth ring conspicuous, medium width, elevated only at back opposite bud, concolorous; root band rather narrow,

oblique, concolorous; rudimentary roots large, few and scattered, 3–4 in rows, purplish brown, decided tendency to premature sproutting; leaf scar glabrate, appressed behind; glaucous band broad and fairly well defined, slightly constricted. Buds, medium size, 8 × 10 mm., slightly exceeding growth ring, suborbicular germination subapical, margins broad and flat, abruptly shouldered at sides and peaked at apex, very few marginal hairs, no apical tufts, distinct basal placs. Leaf sheaths with abundant dorsal vestiture of short, tawny, deciduous hairs, sides glabrate, slightly tinted glaucous, inner base also slightly tinted; throat broad and well defined, lannate, very short, appressed hairs, coarse, hairs at margins; collar broad and well defined, reaching midrib, glaucous; ligule very narrow and peaked at center, ligular process short and stubby, on one side only. Leaf blades spreading, with usually erect tips, medium width, 7–9 cms., very distinct and broad white midrib, margins minutely and uniformly serrulated, scanty basal ciliation.

REFERENCES

Bovell, J. R., and D'Albuquerque, J. P.—Rept. the Sugar Cane Expts. for the Season between 1919–21. Barbados Dept. Agriculture.

Rosenfeld, Arthur H.—Rept. of Special Technologist for Cane. Annl. Rept. Ins. Expt. Sta. of Porto Rico, 1924–25.

* B-1030. See Plate I, opposite page 85.

When imported and by whom unknown. There were 27¾ acres of it at Central Mercedita, Ponce, in 1916, and it is still being grown there. It has also been grown on a small scale at Fajardo.

Soon decumbent, vigorous, a strong stooler, arrowing not noted. Stalks medium length and diameter, green with a dull, brownish-purple flush when exposed, a little bloom. Internodes medium length, somewhat barrel shaped, a little staggered, furrow none. Nodes constricted, oblique; growth ring rather wide, even, bright green, then concolorous; root band narrow, very oblique, 5 to 8 mm., concolorous; rudimentary roots inconspicuous, in 2 or 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, strongly constricted. Buds large, broadly ovate, obtuse, broader than long, 12 to 14 × 10 to 12 mm., exceeding the growth ring, margin broad, shouldered, germination subdorsal, premature, the buds soon sprouting, vestiture scanty, indistinct basal placs and an apical tuft. Leaf sheaths with dense vestiture of suberect tawney hairs, green or faintly tinted, glaucous; throat glaucous, with a few scattered medium long hairs; collar broad, pallid, glaucous or slightly lannate on the margins; ligule

medium length, fimbriate; ligular processes none. Leaf blades erect, two-ranked, flat, broad, 9 cm., glaucous-green, minutely serrulate, the base slightly ciliate.

This cane germinates quickly, grows vigorously and stools unusually well. It has not been sufficiently tested to express a final judgement as to its value, but it promises to be very useful on account of its early maturity. It had more sucrose than any cane analyzed during the first half of December. This is very important, for most of our heavy-tonnage canes are late in maturing and we are greatly in need of early kinds for grinding during the first part of the crop. Apparently this cane will serve also for late spring planting. Its greatest weakness seems to be its unusually strong tendency for the buds to sprout prematurely.

It was not included in the immunity experiment at Santa Rita. At Mercedita it is said to be about medium in its susceptibility to mosaic. It seems to ratoon well and promises to be fairly resistant to root disease. Its reaction to gum disease is not known.

Kind	Date	Age	Extr.	Brix	Sucr.	R. S.	Purity	Fiber
B-1030..........	12-6-20	Pl. 18 mo.	....	17.88	15.10	1.58	84.88	9.98
Ave. of 5 Cheribon........	12-6-20	Pl. 14 mo.	.. ..	. .	13.69	1.67	85.88	12.29
B-1030.	3-9-21	Pl. 16 mo.	66.00	19 70	18 45	0.42	93 64	12.24
Cristalina.. ..	3-9-21	Pl. 16 mo.	69.40	19 09	17.20	0 39	90.52	11.01
B-1030........	6-7-24	Pl. 11 mo.	....	20.90	19 68	0.60	98.92	2nd of 14
B H-10 (12). ..	6-7-24	Pl 11 mo	....	19.20	16.82	0.80	87.60	7th of 14
B-1030........	3-2-25	Pl. 20 mo	.. ..	17.90	16.18	1 03	20 10	5th of 17
B H-10 (1[illegible]....	3-2-25	Pl. 20 mo.	. . ..	17.70	15.98	1 18	90 00	6th of 17
B-1030..	5-14-26	Pl 14 mo	... .	21 40	20 57	0.17	96.16	1st of 12
B H-10 (12). ...	5-14-26	Pl. 14 mo	T. Sug per Ac.	18.65	16 80	0.38	89 12	9th of 12
B-1030.	5-14-26	Pl. 14 mo	3.48	. . ..	19 60	....	91.80	1st of 9
B H-10 (12)....	5-14-26	Pl. 14 mo.	2 92	....	[illegible]	....	89.86	4th of 9

The last four pairs of analyses are of cane from the Hatillo Fruit Farm, where B–1030, on the shaly hills of that property near the Station, has consistently given about the best results of any cane tried since Mr. Earle interested the manager, Mr. W. C. Dreier, in varieties in 1921. This first three sets are the results of extractions in the laboratory mill at the Station, but the last are of commercial quantities of cane ground at Central Victoria and are the basis on which payment was made for this cane. When any cane can so consistently do better than B.H.–10(12) under ANY CONDITIONS WHATSOEVER, it is well worthy of further trial. Tonnage experiments with this variety in comparison with all the other Barbados varieties mentioned in this study, are under way at the Station at present and Mr. Dreier is considerably extending the variety at the Hatillo Fruit Farm.

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ROSENFELD, ARTHUR H.—Estudios de Variedades. Informe Anual de la Estación Experimental Insular de Puerto Rico, Año Fiscal 1923–1924; pp. 69–72; San Juan, 1924.

VEVE, RAFAEL A.—Our Experience with Cane Varieties. Memoirs of the Association of Sugar Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922.

* B–1355.

Mr. Sewall received this cane from the Federal Station at Mayagüez, according to a note by Cowgill, but date is not given. It was growing at this Station in 1911 and 1913 from seed sent by Mr. Sewall, but had disappeared from the collections until seed was brought from Central Mercedita in September, 1919, by Mr. Earle. Over ninety acres of it were grown at that Central in 1916 and it has been grown to some extent at Fajardo, although it is at present little planted there.

Soon decumbent, good vigor and stooling, arrowing not noted, stalks long, medium diameter, green with dull red flush, no bloom. Internodes, medium length, somewhat staggered, abruptly shouldered below at back, furrow none. Nodes constricted; growth ring very broad, 4 to 6 mm., even but encircling the shoulder of the internode, concolorous but often bordered with reddish; root band narrow, oblique, sharply constricted; rudimentary roots obscure, in about 2 rows; leaf scar strongly ciliate with stiff hairs 5 to 6 mm. long, appressed behind; glaucous band narrow, about 6 mm., strongly constricted. Buds ovate triangular, acute, 10 × 10 to 12 × 12 mm., exceeding the growth ring, margin broad, somewhat shouldered, germination apical, vestiture scanty at apex and margin, basal placs well developed. Leaf sheaths with medium vestiture of soft appressed hairs, greenish, glaucous; throat sparingly lannate with some long hairs on the margins; collar pallid, reaching the midrib, sparingly lannate; ligule rather broad, 5 mm., edge fimbriate; ligular processes usually poorly developed. Leaf blades spreading, flat, rather narrow, about 6 cm., light green, margin closely but minutely serrulate, the base ciliate.

This seems to be a cane of only medium value, but not enough is known regarding its characteristics to express a positive opinion.

In the immunity experiment at Santa Rita it made a slightly better showing as regards root disease than the Rayada but fell in the same class in susceptibility to mosaic. Its reaction to gum disease is not known.

Its recorded at the Station as published in Circular 8 was rather

low in total tonnage for the three crops, medium in sucrose and high in purity, the figures being, total tons, 3 crops, 56.75; brix, 16.81; average sucrose, 15.71; purity, 93.3. Recent analyses are as follows:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B-1355	12 2 20	Pl 13 mo	67 8	15 8	12 54	3 06	81 96	11 77
Average of 5 Cheribon	12 2 29	Pl 18 mo			18 69	1 67	85 88	12 29
B-1355	8 9 21	Pl 16 mo	72 4	18 4	17 82	0 396	98 62	12 44
Cristalina	8 9 21	Pl 16 mo	69 4	19 4	17 20	0 89	90 52	11 01

REFERENCES

COWGILL, H. B.—Distribución de Caña para Semilla. Estación Experimental Insular de Puerto Rico, Cir. 8; San Juan, 1917.
EARLE, F. S.—The Resistance of Cane Varieties to the Yellow Stripe or Mosaic Disease. *Ibid,* Bull. 19; 1919.

B-1356.

Noted by Cowgill as having been received by Mr. Sewall from the Mayagüez Station. It was in cultivation at this Station in 1911 from seed sent by Mr. Sewall, Cowgill noting that it is scarcely distinguishable from B-1355. Its record in Circular 8 is total tons in 3 crops, 49.86; brix, 17.86; sucrose, 17 01; purity, 95.2, being the highest purity in the 24 kinds but next to the lowest tonnage. Not seen.

B-1376.

Noted as received from the Mayagüez Station by Mr. Sewall, from whom seed came to this Station in 1911, Mr. Murphey reports on it at Guánica in 1911. Was planted at Central Lafayette in 1914. Cowgill says "seems to be identical with Cristalina in appearance." Its record at this Station as published in Circular 8 was plant cane 41.8 tons, total 3 crops, 67.6 tons, total 3 crops, 67.6 tons, brix, 18.59; sucrose, 18 20; purity, 94 8. The highest sucrose out of 24 kinds and next to the highest purity.

Not seen.

B-1529.

Introduced by Mr. Sewall from Antigua in 1911 Apparently never planted elsewhere.

Not seen.

B-1566.

This seems to have been introduced from Barbados by Mr Murphey. It figures frequently in his reports from Guánica during 1911, 1912, and 1913 and seems to have attracted his very favorable attention. It is said to have decidedly outyielded Otaheite and to ratoon well and

be free from rot. There were four acres at Guánica in 1915. It does not seem to have been planted elsewhere.

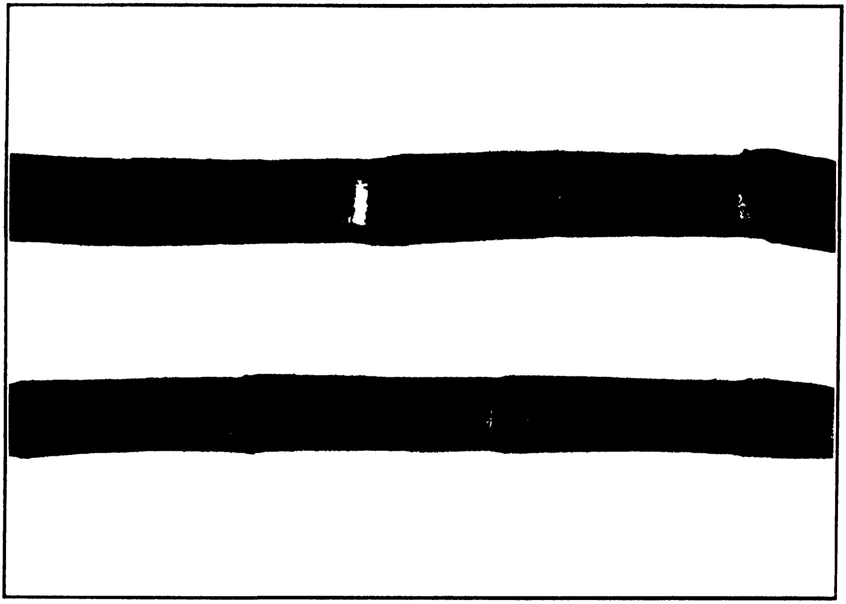
Not seen.

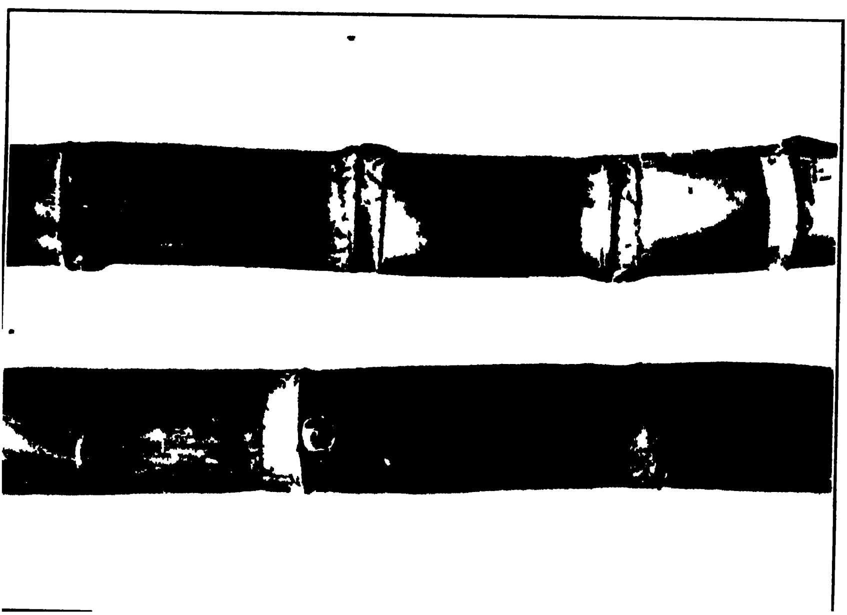
* B-1753. See Plate IX, opposite page 107.

Noted by Mr. Sewall as received from the Mayagüez Station. Grown in considerable quantity at Guánica during 1910–1918, where it is frequently mentioned in Mr. Murphey's reports. He considered it as a very promising kind and frequently called attention to the fact that it is strongly resistant to lime chlorosis. There were 81 acres of it at Guánica in 1915, but it is no longer cultivated there. It was included in the variety experiment at Aguirre in 1911 and was grown at Central Lafayette in 1914–1916. It was formerly considerably cultivated at this Station, seed having been brought from Guánica in 1911, and although it produced the highest sugar per acre out of 24 kinds in the three-year tests reported in Circular 8 it is no longer found here and the recent attempts to bring in seed and reestablish it have failed, on account of its remarkably poor germination. Mr. Dreier, at the Hatillo Fruit Farm near the Station, has also obtained the poorest sort of germination from this variety.

Strictly erect, vigorous, a strong stooler, once germinated arrowing not noted. Stalks slender, 2½ to 3 cm, green, yellow when mature, no flush and no bloom. Internodes medium long, straight, cylindrical, furrow usually evident but slight. Nodes scarcely constricted, growth ring narrow, inconspicuous, concolorous; root band narrow, 6 to 8 mm, yellow; rudimentary roots small, indistinct, in 3 to 4 rows; leaf scar glabrous; glaucous band narrow, 6 to 7 mm., conspicuous. Buds rather small, oval-ovate, with rounded narrowed base and acute point, about 8 × 10 mm., exceeds the growth ring, margin very narrow, germination apical, base sides and apex with appressed hairs. Leaf sheaths subglabrate but with short brown hairs mixed with the bloom, glaucous. Leaf blades erect, narrow, light green.

This is an unusual cane and one clearly having many excellent qualities. Earle considers it to have been dropped from cultivation solely because of its slender diameter, most planters having a strong but unfounded preference for stout canes, but the writer is inclined to think that its poor germination has had an influence. In the Aguirre plots in 1911 this kind gave tons cane, 59.165; brix, 17.97; sucrose, 13.80; purity, 79.8; tons sugar, 5.6. At Central Lafayette in 1914 as plant cane it gave, brix 21.0; sucrose, 18.5; purity, 88.3. Cane grown at La Muda, between Río Piedras and Caguas, analyzed





April, 1917, as plant cane at 14 months, gave, brix, 21.05; sucrose, 19.40; purity, 92.40. It was the highest in tonnage out of six kinds. Its record at the Station as published in Circular 8 is plant cane, 50.22 tons; total, 3 crops, 105.72 tons; average brix, 17.42; sucrose, 15.58; purity, 89.4. It was exceeded in tonnage by D–625, Cavengerie, Sealy Seedling, and B–4596, but figured by the formula now used by Central Vannina in buying cane by sucrose content this gave the highest sugar per acre of any of the 24 kinds tested, averaging 4.09 tons sugar per acre for each of the three crops.

It was not included in the immunity experiment at Santa Rita. At Central Mercedita it is reported to be very seldom attacked by mosaic. Its ratooning power shows it to be fairly resistant to root disease. It has not been tested with gum disease. Its unusual resistance to lime chlorosis has already been noted.

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ROSENFELD, ARTHUR H.—Lista de las Variedades de Caña de Azúcar bajo Experimentación. Informe del Comisionado de Agricultura y Trabajo de Puerto Rico, 1923–24, pp. 146–7; San Juan, 1924.

* B–1809. See Plate II, opposite page 119.

Parentage unknown. Introduced by this Station from Barbados in 1911. It is now in cultivation at various points on the Island on a small scale, in many cases mixed with D–117, which it considerably resembles.

Strictly erect, good vigor, medium stooling, seldom arrows. Stalks long, medium to medium stout, green, a slight reddish flush when fully exposed, only light bloom. Internodes rather long a little flattened, usually abruptly shouldered below on side opposite to bud, furrow broad and rather deep. Nodes prominent, not constricted; growth ring broad, prominently enlarged, root band prominent, enlarged above to meet the swollen growth ring; rudimentary roots in 2 or 3 rows; leaf scar glabrous; glaucous band slightly constricted, well defined. Buds large, triangular-lanceolate, acute, 12 to 15 × 15 to 20 mm., exceeding the growth ring by one-half the length, margin narrow but shouldered; germination apical, apex bearded. Leaf sheaths with a scanty vestiture on the back which is soon deciduous becoming glabrate, green, glaucous; throat lannate and with a medium vestiture of hairs; collar broad, dark brown, reaching the midrib, glaucous, the margins sparingly lannate; ligule medium length, edge even; ligular processes none, or poorly developed. Leaf blades erect

except the tips, medium width, 6 to 7 cm., bright green, minutely but closely serrulate to the base

This is a good, heavy-tonnage, general-purpose cane which matures fairly early It may be safely planted as "Primavera". It is best adapted to "vega" lands, but also grows well in the red shale hills. In 1915 it stood second in tonnage out of 20 kinds at this Station, giving 9 tons more than Cristalina.

It was not included in the immunity experiment at Santa Rita but it has contracted mosaic on the Station grounds, being apparently in about the same class in regard to resistance as Rayada and Cristalina Its reaction to gum disease is not known.

As seen from the following selected analyses, it is of about the same sucrose value as Cristalina.

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B 1809 (1)	1915	Pl		17 84	15 48		89 8	
Cristalina	1915	Pl		17 98	16 55		92 0	
B 1809	May 1916	Rat		18 50	17 2		92 98	
Cristalina	May 1916	Rat		18 80	17 8		94 14	
B 1809	1-8-20	Rat 14 mo	63 2	19 15	17 52		90 96	
B 1809	12-18-20	Rat 10 mo	69 4	17 86	14 61	1 90	84 0	12 24
Rayada	12-18-20	Rat 10 mo	71 1	15 88	13 45	1 76	84 96	8 08
B 1809	12-15-20	Rat 14 mo	70 8	16 63	14 28	2 02	85 56	11 68
Cristalina	12-15-20	Rat 14 mo	70 0	17 50	15 53	0 28	88 74	9 60
B 1809	2-2-21	Rat 16 mo	66 6	18 35	16 92	0 81	92 2	12 69
Cristalina	2-2-21	Rat 16 mo	70 3	17 85	16 15	0 83	90 42	10 69
B 1809	4-11-21	Pl 17 mo	64 50	18 80	17 40	0 531	92 55	11 52
Cristalina	4-11 21	Pl 17 mo	70 10	18 10	16 92	0 265	92 48	10 47
B 1809	Jan 1925	Pl 17 mo	Aguirre	17 60	15 09		85 70	Ton Sug per acre 7 78
B 1809	Jan 1925	Pl 17 mo	Aguirre	17 20	14 68		85 30	Ton Sug per acre 6 91
B 1809	Jan 1925	Pl 17 mo	Aguirre	17 15	14 48		84 10	Ton Sur per acre 6 44

(1) Fourth in sucrose out of 37 kinds Cristalina average, 8 plots, sucrose, 17 27; highest, 18 18 P R-208, 17 59 B-376, 18 18

The Aguirre showing is certainly excellent and, with promising results at the Hatillo Fruit Farm obtained by Mr Dreier, who is a careful observer, as well as most of the small plants showing up well wherever seen over the Island, it is evident that this old cane is worthy of much further detailed study We have it in tonnage experiments with practically all of the other Barbados seedlings we have, few of which have ever been carried through actual tonnage tests here before.

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VEVE, RAFAEL A.—Our Experience with Cane Varieties, Memoirs Assn. Sug. Tech. of P. R., I, 1, pp. 28-31; June, 1922.

B-3289. See Plate IX, opposite page 107.

Noted by Mr. Sewall that the seed came from the Mayagüez Station. Grown at this Station during 1912 and 1913 from seed received from Mr. Sewall. It was grown in a small way at Fajardo up to 1917, but its record there was poor, being twenty-second in tons sugar per acre out of 25 kinds. It was lowest in tons sugar per acre among the kinds tested at Aguirre in 1911, where its record was as follows: Tons cane, 59.702; brix, 16.47; sucrose, 12.89; purity, 78.3; tons sugar, 5.34. At this Station in 1913 it gave, tons cane, 34.05; sucrose, 16.58; purity, 89.9.

Not seen.

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WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands. Pt. I, Experiments with Varieties of Cane, 1919–20. Issued by the Comm. of Agriculture for the West Indies; 1921.

* B-3390.

Said to be a seedling of D-95. Probably introduced from Barbados by Mr. Murphey. At least he reports on it as in cultivation at Guánica in 1911, at which date seed was brought to this Station from there It was at Fajardo as early as 1914. Brought to this Station from Fajardo in November, 1919.

Soon prostrate, medium vigor and stooling, arrows freely. Stalks long, medium slender, dull green with red flush, light bloom. Internodes long, somewhat enlarged below, straight or nearly so, furrow evident but shallow. Nodes scarcely constricted, oblique, growth ring broad, 3 to 5 mm., nearly even, bright green; root band strongly oblique, concolorous, rudimentary; roots rather crowded, in 3 or sometimes 4 rows; leaf scar glabrous, closely appressed behind; glaucous band narrow, somewhat constricted. Buds triangular-lanceolate, very long, 10 to 11 $\times$ 15 to 20 mm., exceeding the growth ring by half or more of the length, margin medium, shouldered below, germination apical; basal placs and scanty vestiture on sides and apex. Leaf sheaths glabrous, green scarcely glaucous; throat broad, densely lannate, very few long hairs; collar broad reaching the midrib, lannate; ligule very narrow, about 2 mr., somewhat fimbriate; ligular processes none. Leaf blades spreading, somewhat plicate rather narrow, about 6 cm., light green very sparingly serrulate nearly even, base not ciliate.

But little is known as to the agricultural value of this cane. It

has a good record on red lands in Barbados. In Antigua in 1918–19 it rankt 39th in production of sugar per acre out of [illegible] varieties tried—rather low!

It was included in the immunity experiment at Santa Rita but was in the small list that failed to contract the mosaic. Nothing is known as to its resistance to any of our three serious diseases.

The only available analyses are the following:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B-3390	1915			18 0	16 45		91 5	... ...
Cristalina	1915			17 98	16 55	.	92.0	..
B 3390	May 1916	Rat		18 4	17 2		93.47	.. ...
B-3390	1 14 21	Pl 14 mo	60 6	15 10	12 06	1 60	79 80	12 40
Cristalina	1 14 21	Pl 15 mo	70 0	17 25	15 96	0 87	92 52	9 60
B-3390	4 8 21	Pl 17 mo	69 7	18 80	16 18	0 652	86 41	10 90

EARLE, F. S.—The Resistance of Cane Varieties to the Yellow Stripe or Mosaic Disease. P. R. Ins. Expt. Sta. Bull. 19; 1919.

WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands. Pt. I, Expts. with Varieties ol Sugar Cane. Comm. of Agr. for the W. I., 1921.

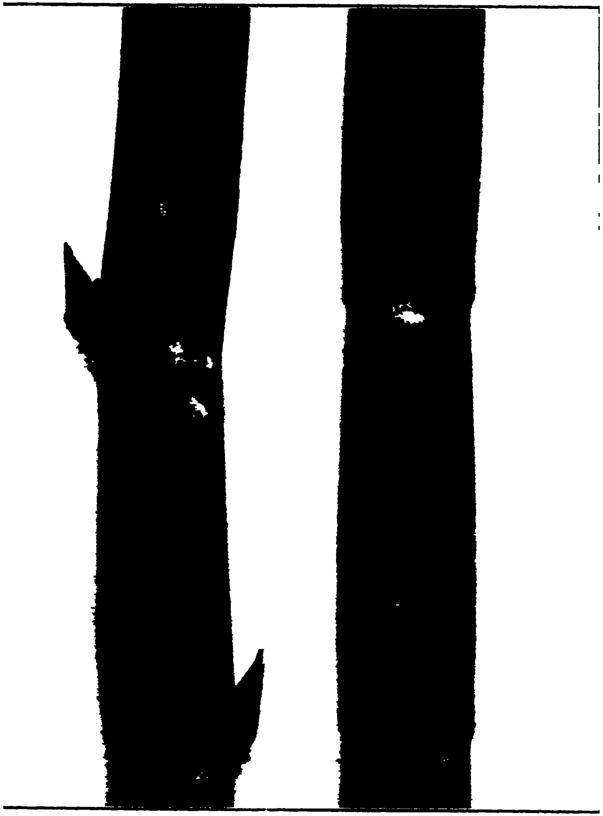
B-3405. See Plate X, opposite page 111.

A seedling of D-74. Probably introduced by Mr. Murphey from Barbados. It is mentioned in his Guánica reports for 1911. It first came to this Station from Guánica in 1911. It was reported from Fajardo in 1913. The first record at this Station is in 1911. Seed cane has been distributed to planters in many parts of the Island.

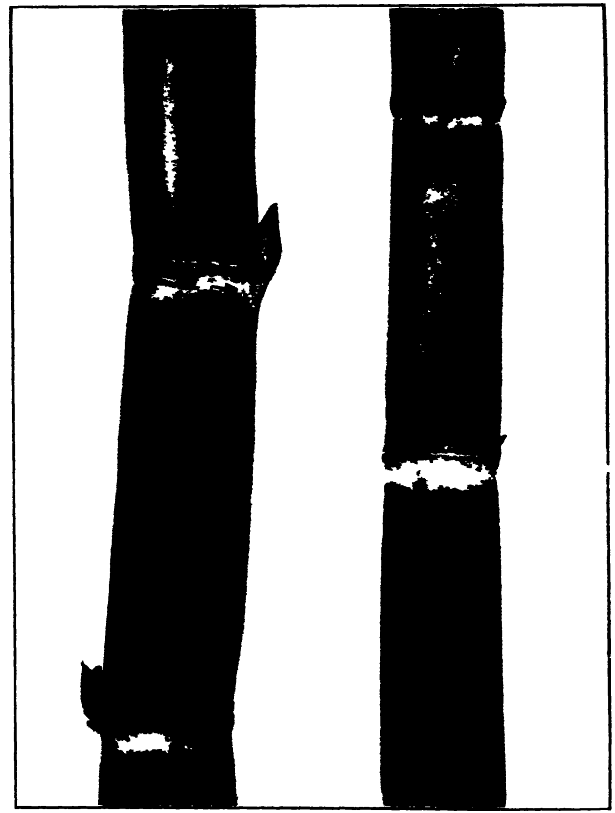
The description given under Sealey Seedlings fits this cane in every particular except that the collar is lannate while in the former it is glaucous or only slightly lannate on the extreme margins. This cane is also usually a little stouter and the leaves average a little broader, but these differences can hardly be exactly defined.[1]

This is a vigorous cane of heavy tonnage and is an especially strong ratooner. It is adapted to either high or low lands. It can be safely recommended for general planting on lands where Rayada and Cristalina are beginning to fail. It is, however, rather late in

[1] From brief description of Sealey Seedling, B-3405 and B-3412 recently published in Rept. Imp. Dept of Agric West Indies, Sugar Cane Experiment in Leeward Islands, Antigua and St Kitts—Nevis, 1918–19 (issued 1921) pp. 4–5, it seems probable that all of the material we have here in Proto Rico under these three names really belongs under B-3412. That is described as "erect, narrow, light-green leaves, medium-sized cane, slightly zig-zag Internodes cylindrical, fairly long and slender, well-defined channel. Color greenish brown. Buds conical, long and pointed. Arrows sparsely." This fits our cane in every particular Sealey seedling differs in color, being brownish green to brownish yellow, and in arrowing very freely. B-3405 is described as a russet-brown cane with broad, flat, adhering buds. We have no cane in Porto Rico which fits this description.



B 3405



B 3412

maturing and should be planted in the fall as "gran cultura", or if planted in the late spring it should be held over until the second year. If cut too green this cane is very poor in sugar, but when fully matured it develops a very satisfactory percentage of sucrose and purity.

It is quite resistant to root disease, as shown by its great ratooning power. It was not included in the immunity experiment at Santa Rita, so its behavior toward mosaic has not been fully tested. Some plots at Central Coloso of what was believed to be this cane were showing rather unusual resistance to it, but some plantings near Piedras are suffering severely from it. Its reaction to gum [illegible]se has not been determined.

A few selected analyses follow:

Kind	Date	Age	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
B-3405	1915	Pl.	.....	17.17	15.19	.....	88.4	.....
Cristalina	1915	Pl.	.....	17.98	16.55	.....	92.0	.....
B-3405	May, 1916	Rat.	.....	18.6	17.1	.....	91.93	.....
Cristalina	May, 1916	Rat.	.....	18.8	17.8	.....	94.14	.....
B-3405	12-8-20	Rat. 10 mo.	77.0	18.21	9.17	8.27	68.66	10.12
Cristalina	12-8-20	Rat. 10 mo.	78.0	15.63	13.41	1.78	85.76	10.80
B-3405	12-12-20	Rat. 14 mo.	70.9m	15.18	12.15	2.86	80.00	9.32
Cristalina	12-12-20	Rat. 14 mo.	70.0	17.50	15.53	0.26	88.74	9.60
B-3405	2-2-21	Rat. 16 mo.	65.7	17.10	15.17	0.986	88.12	12.87
Cristalina	2-2-21	Rat. 16 mo.	70.8	17.95	16.24	0.33	90.42	10.69
B-3405	4-12-21	Pl. 18	70.4	18.70	17.13	0.583	91.60	11.84
B-3405	5-14-26	Pl. 14	Hatillo Fruit	18.10	16.20	0.150	91.01	.....
B H-10 (12)	5-14-26	Pl. 14	Hatillo Fruit	18.85	16.80	0.350	89.12	.....

* Third in tonnage both as plant and ratoon out of 20 kinds.

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WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands, 1919–20. Pt. I, Expts. with Varieties. Issued by the Comm. of Agr.

B-3412. See Plate X, opposite page 111.

Seedling of D-74. Presumably introduced from Barbados by Mr. Murphey. It figures prominently in his Guánica reports for 1910, 1911 and 1912, being at one time one of the principal canes planted there, especially on hill lands. Seed was brought to this Station from Guánica in 1911. It has also been largely planted at Fajardo, but is practically abandoned there now, as it was considered too low in sugar. It is to be seen in all parts of the Island and is probably more widely planted than any of the other Barbados seedlings, except BH 10(12).

For description see Sealey Seedling (and note under B-3405), from which it can be distinguished, if at all, only by the less lannate throat. It perhaps averages a little stouter than the form we have as Sealey Seedling, but it varies greatly in diameter according to vigor and condition of growth.

In agricultural value it seems to resemble B-3405 and Sealey Seedling as closely as in taxanomic characters. It has been much more widely planted than either of them, especially at Central Guánica, but it is hard to see on what grounds it can be separated from them. It grows best on low, moist lands, but in such localities it is difficult to ripen it enough to develop much sucrose. It is, there[illegible] usually planted as a hill-land cane. It is to be recommend[illegible] lands where Rayada and Cristalina fail, but great care shou[illegible] taken not to cut it green. When really mature it makes a good y[illegible] of sugar and it can be depended on for better tonnage than Cris[illegible]lina.

This kind has good resistance to root disease and always ratoons well. It is usually considerably troubled with leaf spot, sometimes enough so to interfere with growth, especially when young. It is noted in some of the Guánica reports that it resists the lime chlorosis as well as B-1753. Its behavior toward mosaic is peculiar in that it takes the disease less readily than some other kinds, but when once attacked it suffers severely, turning quite yellow and being conspicuously dwarfed. Its reaction to gum disease has not been determined.

The following analyses indicate how poor it is in sugar when green but that it sweetens up well at full maturity.

Kind	Date	Age	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
B-3412	4-17-17	Pl. 14 mo.	....	20.40	18 50	....	90.70	....
B-3412	2-12-18	Pl. 16 mo.	....	15.50	12 64	....	80.90	....
B-3412	12-15-20	Rat. 14 mo.	73.40	12.51	8.30	3.42	66.84	10.60
Cristalina	12-15-20	Rat. 14 mo.	70 0	17.50	15.53	0.28	88.74	9 60
B-3412	1-26-21	Rat. 15 mo.	70.8	14.15	10.74	2 006	70.89	11.06
Cristalina	1-26-21	Rat. 15 mo.	70.3	17.85	16.14	0 33	90.42	10.69
B-3412	4-11-21	Pl. 18 mo.	71.2	17.70	16.02	0.58	90.55	12.67
B-3412	2-7-21	Pl. 16 mo.	72.1	16.80	14.64	1.30	87.27	10.37
Cristalina	2-7-21	Pl. 16 mo.	68.6	17.90	16.14	0.808	90.16	18.01
B 3412	1-24-23	Pl. 18 mo.	Aguirre	17.90	12.96	....	72.40	....
B-3412	2-23-23	Pl. 14 mo.	Aguirre	19.30	15 02	....	77.90	....
B-3412	3-22-23	Pl. 15 mo.	Aguirre	18 60	15.72	....	84.60	....
B-3412	4-21-23	Pl. 16 mo.	Aguirre	20.45	18.05	....	88.30	....
B-3412	5-15-23	Rat. 12 mo.	Ins. Sta.	20.20	18 72	....	92.67	....
B-H-10 (12)	5-15-23	Rat. 12 mo.	Ins Sta.	19.90	18.84	....	94.67	....
			Tns. cane			T. sug. p. a.		
B-3412	3-21-24	Pl. 22 mo.	Hatillo	38.14	16 63	4.56	86.30	....
Rayada	3-21-24	Pl. 22 mo.	Hatillo	6.56	16.67	0.80	88.20	....
B-3412	2-27-26	Rat. 12 mo.	Ins. Sta.	21.04	12.72	....	79.25	....
H-109	2-27-26	Rat. 12 mo.	Ins. Sta.	25.00	16.70	....	88.10	....

Of the Aguirre tests, Mr. Earle wrote in his records:

"As usual, late in maturity, but has made heavy tonnage and has kept in the field among the best. One of the few that would hold over to next crop without injury."

Mr. Dreier at the Hatillo Fruit Farm has frequently run this cane as *"caña quedada"* with most excellent results.

Properly handled, as Earle has so frequently indicated, this cane can occupy a decidedly useful place in our scheme of hillside plantings. The writer knows of very few types of its general hardiness which, once they have attained a reasonable purity, hold their condition over long periods as will this variety.

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B-3578.

No data as to introduction. It was included among the canes sent from Fajardo for the immunity test at Santa Rita. Seed was also brought to this Station from Fajardo in November, 1919. There is no other record of its occurrence in the Island.

It is so little cultivated that a description is omitted.

It failed to contract the mosaic in the Santa Rita Experiment. It seemed to resist root disease unusually well and came through to the end of the experiment in good general condition and vigor.

B-3675.

Mentioned in Mr. Murphey's notes from Guánica in 1912. It seems to have been in cultivation at this Station in 1913, but the record is not clear.

Not seen.

* B-3696.

Mr. Sewall's notes show that he obtained seed of this kind from the Federal Station at Mayagüez. Seed from him was planted at this Station in 1911. It does not seem to have been grown at Guánica, but was included in the variety test at Aguirre in 1911. It is grown on a small scale only at Fajardo. Seed was again brought to this Station in November, 1919, this time from Fajardo. This is

[illegible] Company, near Rio [illegible] this Station some years ago that was [illegible] to give good results the planting was extended [illegible] time to time and it was not noted until the spring of 1909 that two kinds of cane were represented. The greater part was of this kind as described below, but a small portion was clearly different, having a conspicuously ciliate leaf scar. This temporarily led to further confusion, as from this character it was carelessly considered to be B–3922. It now appears that this is the true B–3747, while the greater part of the planting is B–3696.

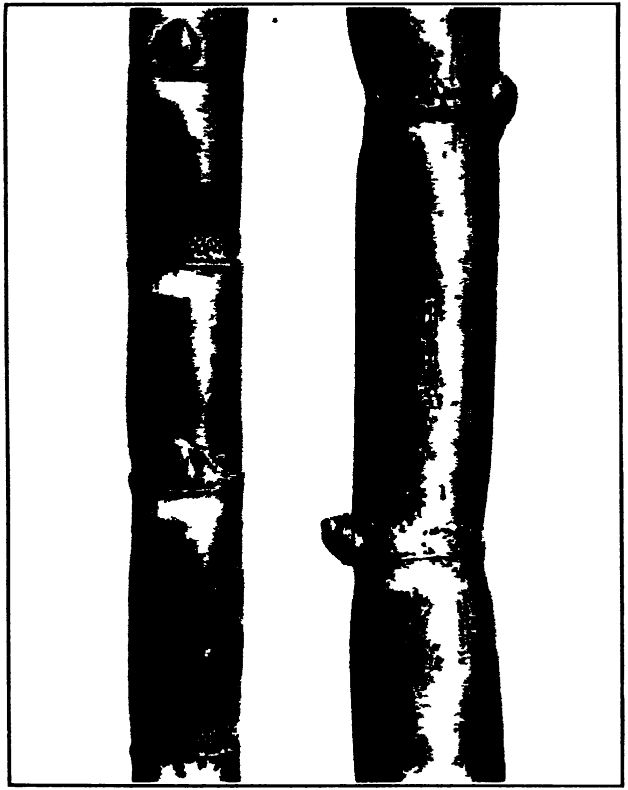
Erect, seldom decumbent, good vigor, free stooling, seldom arrows. Stalks long, medium diameter, dull green with a red flush when exposed, medium bloom. Internodes medium to long, laterally compressed, somewhat inequilateral, the front straight and the back somewhat convex, conspicuously staggered, furrow well developed. Nodes but little constricted, oblique; growth ring medium width, slightly depressed, bright green; root band oblique, 6 to 8 mm., slightly elevated, concolorous; rudimentary roots crowded, small inconspicuous, in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band well marked, slightly constricted. Buds ovate, obtuse, 12 × 15 mm., exceeding the growth ring by one-half, margin rather broad, uniform, germination apical, basal place and a marginal vestiture of white hairs. Leaf sheaths with sparse vestiture of short hairs soon glabrate, green, not glaucous; throat lannate and with tufts of long hairs at the margins; collar narrow, not reaching the midrib, glaucous, the margins lannate; ligule about 3 mm., the margin even; ligular processes small, poorly developed. Leaf blades spreading, flat rather narrow, about 6 cm., light green, very minutely serrulate, the base even, not ciliate.

This seems to be a good general-purpose cane yielding a fairly good tonnage. It does not ripen quite as early as Cristalina but at full maturity it develops high sucrose and purity.

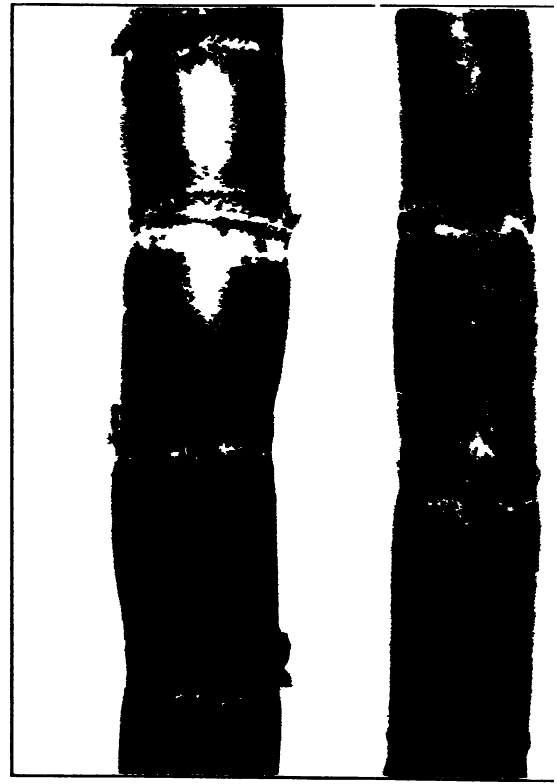
It was included in the Santa Rita immunity experiment, but a very poor stand was secured and the few plants which survived failed to take the mosaic. It has contracted it, however, at the Hatillo Fruit Company farm, seeming to suffer about like the Rayada. Its reaction to gum disease has not been determined.

In the Aguirre test plots in January 1911 it gave: tons cane, 70.205; brix, 17.65; sucrose, 14.77; purity, 83.7; tons sugar, 7.47.

This is a fine record, though the cane was evidently still green when cut. Its best record is for a car from the Hatillo Fruit Com-



B 3708



B 3747

[illegible] Central Vannina June 11, 1920, which gave: brix [illegible]; sucrose, 20.35; purity, 91.67. It was sold on the basis of sucrose content and under the prevailing terms brought 9.89 per cent to the grower in sugar on the total weight of cane. A cane capable of such a record is certainly worth further trial. Some analyses of immature cane are as follows:

Kind	Date	Age	Arrows	Extr	Brix	Sucr	R S	Purity	Fiber
B-3696	1-12-21	Pl 15 mo	No	72 7	14 95	11 66	2 09	77 99	9 92
Cristalina.	1-12-21	Pl 15 mo	No	70 0	17 25	15 96	0 37	92 51	9 60
B 3696	2-11-21	Pl 16 mo	No	72 9	16 65	13 59	1 92	81 62	11 92
Rayada	2-11-21	Pl 16 mo	No	63 6	1 15	15 25	0 81	88 92	12.87
B 3696	4-11-21	Pl 18 mo	No	71 6	17 60	15 85	0 77	90 05	11 96
B-3696	2-11-26	Pl 16 mo	No		17 92	14 45		81 80	
B H 10 (12)	2-11-26	I 1 16 mo	No		17 48	15 00		86 06	

The last series of analyses represent the result from a tonnage experiment at the Station, the cane being ground at Central Vannina. B-3696 in this experiments produced 41 94 tons of cane and 4 28 tons of sugar per acre, as against 54.81 and 6.05 tons respectively for the B.H. 10(12), which was used as a check This experiment was made on good quality *vega* land. B-3696 stood sixth in sucrose in juice and per acre, amongst sixteen of our most promising kinds, while B.H.-10(12) stood fourth in sucrose in juice, but second in sugar per acre.

This variety is certainly worthy of further trial, particularly as an upland cane.

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CRAWLEY, J. T.—Third Annual Report of the P. R. Ins. Expt. Station. Bull. 5; Aug., 1913.

ROSENFELD, ARTHUR H.—General Variety Studies. 14th *Ibid*, 1923–24. pp. 62–4.

B-3696, Striped.

Mr. Luis Serrano has encountered and bred true to type a very pretty striped mutation of this variety, which in everything but color, seems identical with the parent variety. It should be tried out in comparison with the self-colored type in tonnage experiments.

B-3708. See Plate XI, opposite page 115.

Mr. Sewall notes having received this cane from the Mayagüez Station. This Station received it from Mr. Sewall in 1911. Ratoons in 1913 gave: tons, 27.87; brix, 18.88; sucrose, 17.99; purity, 94 7. Its record in Circular 8 is total tons for crops, 47.81; brix, 18.44; sucrose, 17.27; purity, 93.6. The lowest in tonnage out of 25 kinds.

Not seen.

B-3747. See Plate XI, opposite page 115.

This kind was included in the plantings made at this Station in 1911. Seed from Central Guánica. In 1915 as plant cane it gave: tons cane, 27.42; brix, 19.19; sucrose, 17.81; purity, 92.8. Cristalina from same field gave, tons, 22.10; brix, 17.98; sucrose, 16.55; purity, 92.0. There is no other record of this cane in Porto Rico except the planting on the farm of the Hatillo Fruit Company already noted. Where recently sorted out and planted in pure culture it is making a good growth and promises a heavy yield. An analysis made June 24, 1920, gave: brix, 21.12; sucrose, 19.07; purity, 90.29. Figuring according to the Vannina contracts at 65 per cent of the yield of sugar this would give 9.28 per cent to the grower. It closely resembles B-3922, but the cilia on the leaf scar are even longer and more abundant and the bud is a little longer and more acute.

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B-3750.

Introduced by this Station in 1911 from Barbados. No records of results.

Not seen.

B-3819.

Probably introduced by Mr. Murphey from Barbados. It figures frequently in his reports from Guánica during 1911, 1912 and 1913, and as much as 26½ acres of it was grown at Guánica in 1915. No record of its being planted elsewhere.

Not seen.

B-3859. See Plate XII, opposite page 123.

Introduced by this Station in 1911 from Barbados. There is now a considerable acreage of it at the Hatilló Fruit Company's farm near Río Piedras from seed obtained here. Seed was sent from Fajardo for the immunity experiment at Santa Rita, where it seemed strongly resistant to mosaic. It was grown on a field scale at Fajardo and does not seem to have been planted elsewhere in the Island. Seed was again brought to the Station in the fall of 1919 from the Hatillo Fruit Company's farm.

It is a strong-growing dark-purple cane but it has not been sufficiently tested to venture an opinion as to its real value. In 1915 as plant cane it gave: tons, 26.10; brix, 16.66; sucrose, 14.56; purity, 87.5. On January 14, 1921, as plant cane at 15 months it gave only brix, 14.10; sucrose, 10.84; purity, 76.87; showing that it is rather late in maturing. The following further analyses have been made:

Location	Date	Mill	Brix	Sucrose	Purity	Age
Ins Sta	IV-28 21	Hand	18 40	16 51	89 07	18 mths
Cristalina	IV-28 21	Hand	18 80	16 92	98 48	18 mths
Aguirre	I 24 28	Hand	19 90	16 95	85 20	13 mths
Aguirre	II 28 23	Hand	20 40	17 45	85 50	14 mths
Aguirre	III 22 28	Hand	20 30	18 22	89 90	15 mths
Aguirre	IV 21 28	Hand	19 75	17 30	87 60	16 mths
Ins Sta	V-11 28	Hand	21 20	19 45	91 75	12 mths ratoons
Cristalina	V 14-28	Hand	19 90	18 84	94 67	12 mths ratoons
Aguirre	XI 29 24	Hand	14 70	11 49	78 20	16 mths G C
Aguirre	XII 18 24	Hand	16 75	14 55	86 90	16½ G C

Earle reported on this variety from Central Aguirre that—

"It looks well in all new plantings, keeps well in field and is well adapted to South Coast."

Erect, at length recumbent, fairly vigorous, good stooler. Stalks long, medium girth, purple, medium bloom. Internodes medium length, somewhat tumid, staggered, furrow narrow and shallow, sometimes missing. Nodes conspicuous, oblique; growth ring narrow, 2–4 mms., even brown to concolorous; root band wide, oblique, yellowish green to concolorous; rudimentary roots large, distinct and crowded, in 3–4 rows, purple; leaf scar glabrate, appressed behind; glaucous band medium width, constricted and distinct. Buds medium to large, 8–10 mms., plump, oval, exceeding growth ring by one-fourth, germination apical, margins narrow, glabrate, on upper half only, short apical tuft, light basal places. Leaf sheaths with sparse vestiture of tawny hairs at back, sides glabrate, tinted inside and out; throat wide, distinct, covered with black wax, long and coarse hairs at sides; collar broad, reaching midrib, glaucous; ligule narrow, fiambrate, ligular process none. Leaf blades erect with declining tips, susceptible to leaf spot, medium width, about 6 cms, dark green, minutely and uniformly serrulated, sparse basal ciliation.

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Idem.—1919–20.

* B-3922. See Plate II, opposite page 119.

Seedlings of B-647. Probably introduced from Barbados by Mr. Murphey. It is frequently mentioned in his reports at Guánica during 1911 and 1912. Seed was brought here from Guánica in 1911. It was being very extensively planted at Guánica up to the mosaic outbreak in 1919. Since then in has been little planted, since it suffers seriously from this disease. It was in cultivation at this Station in 1911 and 1912. It has been somewhat cultivated at Fajardo but with less satisfactory results than at Guánica. Not seen in other parts of the Island.

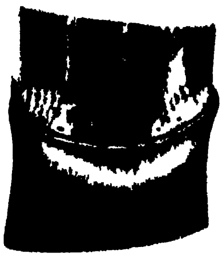
Erect but at length declined, vigorous, a good stooler, seldom arrowing. Stalks long, medium diameter, green with a reddish flush, light bloom. Internodes medium to long, nearly cylindrical but a little flattened, sometimes shouldered below, straight or a little staggered, sometimes checking in lines, furrow slight but evident. Nodes slightly constricted, oblique; growth ring poorly defined, often purplish; root band oblique, narrow, 5 to 8 mm., concolorous, rudimentary roots small, crowded, in about 3 rows; leaf scar conspicuously ciliate with white, erect hairs about 3 mm. long; glaucous band well marked, about 8 mm., somewhat constricted. Buds usually tinted, broadly triangular-ovate, obtuse, often broader than long, 10 to 12 × 10 mm., slightly exceeding the growth ring, margin medium width, uniform, germination apical or subapical, with basal placs and scanty marginal vestiture. Leaf sheaths with short scanty vestiture, green, little or no bloom; throat narrow, pallid, sparingly lannate, and with a circle of scattered, rather stout hairs, especially on the margins; collar narrow, pallid, scarcely reaching the midrib, minutely lannate; ligule about 3 mm., minutely fimbriate; ligular processes none or poorly developed. Leaf blades spreading or somewhat erect, about 6 cm., light green, minutely serrulate, the base somewhat ciliate.

In the Guánica district, where it was usually planted as *gran cultura,* this cane gave a heavy tonnage and very satisfactory sucrose. It has not been sufficiently tested elsewhere.

It is fairly resistant to root disease and ratoons well but it suffers seriously from mosaic, being rather more susceptible than Rayada and Cristalina. Its resistance to gum disease has not been tested. It is a soft cane and is often badly eaten by rats.

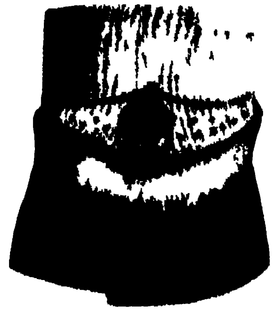
In January, 1914, one plot at Guánica gave: tons cane, 60.81; sucrose, 14.7; purity, 82.8. The remainder of the field in other varieties gave only 42.82 tons. In February, 1914, another field gave: tons cane, 62.84; sucrose, 15.6; purity, 85.9; tons sugar, 7.66; Fajardo in 1916 reports: tons cane, 21.55; sucrose in cane, 12.6; purity,

PLATE II



B 1809

B. 3922



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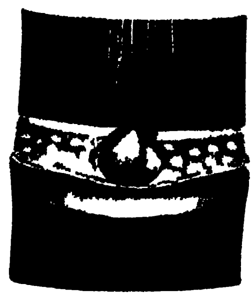

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Illustrations by
Mario BRAU.

89.4; tons sugar, 2.71. Other reports are still lower. The few available late analyses follow:

Kind	Date	Age	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
B-3922	12-15-20	Rat 14 mo.	70 9	14.88	10 89	2 70	72.50	11.45
Cristalina	12-15-20	Rat. 14 mo	70 0	17.50	15.53	0 28	88 74	9.60
B-3922	2-11-21	Pl. 16 mo.	71 8	17.05	15 35	0.91	90.02	12.40
Rayada	2-11-21	Pl. 16 mo.	68.6	17.15	15 25	0.81	88 92	12.87
B-3922	1-24-23	Pl. 13 mo.	Aguirre	18.90	16.90	...	89.40	...
B-3922	2-28-23	Pl. 14 mo	Aguirre	20 20	17 19	...	85 10	...
B-3922	3-22-23	Pl. 15 mo.	Aguirre	20.70	18.45	...	89.10	...
B-3922	Dec. 24	Pl 16 mo.	Aguirre	17 00	14.84	...	87.30	...
B-3922	Dec 24	Pl. 16 mo.	Aguirre	18 00	15.92	...	86.30	...

The last two Aguirre analyses represent factory figures from a seven-acre *poyal* field at Hacienda Isidora at Central Aguirre, which field produced 45.53 tons of cane and 5.35 tons of sugar per acre—not at all a bad showing for this type of land. Earle considered this variety well adapted to the South Coast.

REFERENCES

FOSS.—Summary of Cane Varieties at Central Aguirre for Crop 1924–25.

WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands, 1919 20. Pt. 1, Expts, with Varieties, pp. 1–53. Comm. Agr. for W. I.

B-4028.

Seed of this kind was brought to this Station from Guánica in 1911. It is growing in the Fajardo Experimental plots but it does not seem to have been extended on a field scale. Seed was brought from Fajardo to this Station in November, 1919. It was also sent from Fajardo for the immunity test at Santa Rita, but it failed to germinate.

B-4507.

Introduced from Antigua by Mr. Sewall in 1911. It does not seem to have been planted elsewhere.

Not seen.

B-4578. See Plate XIII, opposite page 121.

This kind was planted at this Station in 1911 with seed brought from Central Guánica. Only very poor yields are recorded. It does not seem to have been planted elsewhere.

Not seen.

REFERENCES

BOVELL, J. R., AND D'ALBUQUERQUE, J. P.—Seedling Canes and Manurial Experiments for the Season 1911-13. Local Dept. of Agr. Barbados.

WATTS, FRANCIS—Sugar-Cane Experiments in the Leeward Islands in the Season 1919–20. Pt. I. Expts. with Var. of Sugar Cane. Issued by the Commissioner of Agriculture for the West Indies.

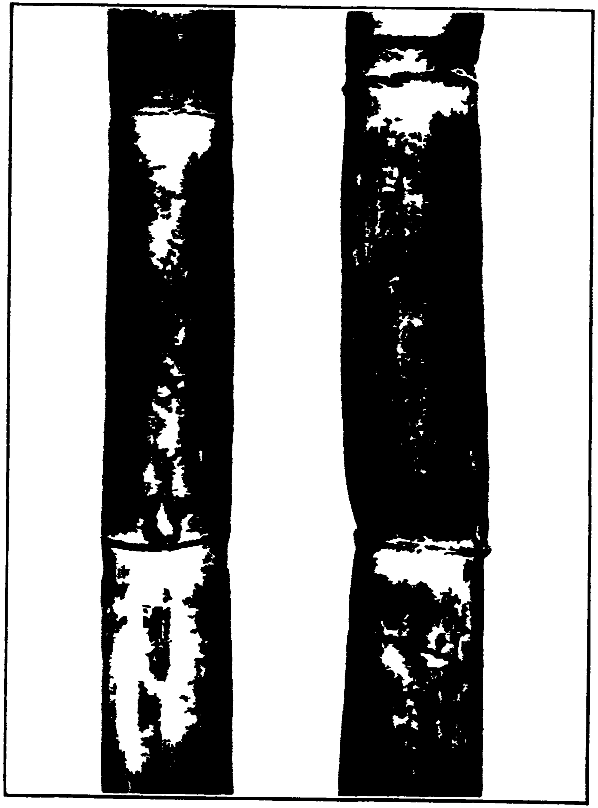
*** B 4596.** See Plate XIII, opposite page 121.

Seedling of B–521.—Introduced from Antigua by Mr. Sewall in 1909. Mentioned in Mr. Murphey's report form Guánica in 1910, but seems to have been very little planted there. It was planted in a small way at Fajardo for a number of years, 13.55 acres being harvested in 1919. It was tested at Central Lafayette, 1914–1916. It has been considerably planted at this Station, seed being obtained from Mr. Sewall in 1911, and seed has been widely distributed on account of supposed disease resistance.

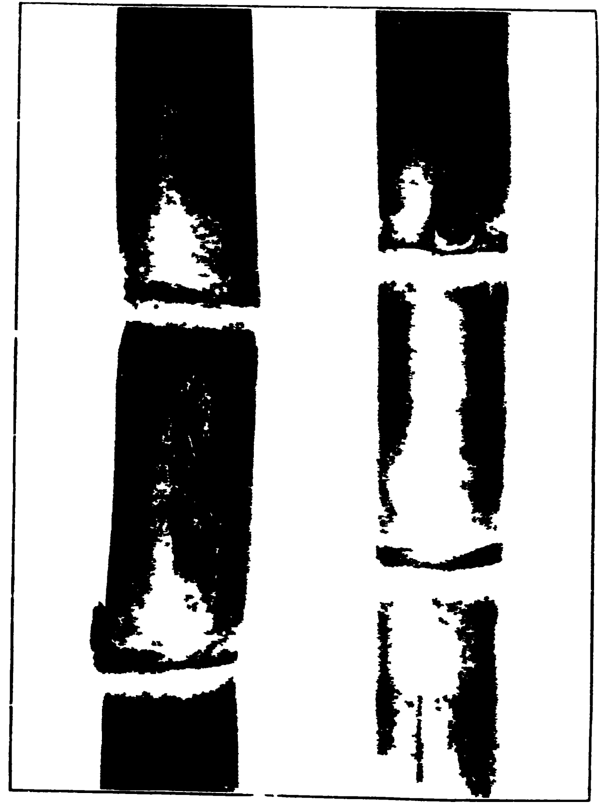
Erect, or at length decumbent, vigorous, a free stooler, arrows frequently. Stalks long, medium to medium small diameter, green with dull reddish flush, usually checking in lines, but little bloom. Internodes medium length, flattened, slightly tumid, nearly straight, furrow fairly well marked. Nodes constricted, oblique, growth ring narrow, inconspicuous, even concolorous; root band narrow, oblique 5 to 8 mm., bright green; rudimentary roots large, yellowish, crowded, in 2 to 3 rows; leaf scar glabrous, appressed behind; glaucous band, narrow, 7 to 8 mm., sharply constricted, conspicuous. Buds large, broadly ovate, obtuse, 12 to 13 × 12 to 13 pm., exceeding the growth ring, margin broad. 2 mm. or more, slightly shouldered, germination subapical, nearly glabrous, apical and marginal hairs short and scanty. Leaf sheaths glabrous, green, glaucous: throat lannate and with a sparing vestiture of medium hairs on the margins; collar broad, pallid, reaching the midrib, glaucous, the margins lanrate; ligule about 4 mm., the margin undulate and slightly fimbriate; ligular processes none. Leaf blades spreading, abundant. flat, somewhat 2-ranked, 6 cm., light green, minutely serrulate, the base even, not ciliate.

The agricultural value of this cane is still uncertain. It is adapted to low, wet, compacted lands where Rayada begins to fail and in such localities it gives heavy tonnage and ratoons well. It makes a poor growth on dry hill lands. It is very late in maturing and when green gives the lowest sucrose and purity of any kind tested. Our records are far from complete but they fail to show that it ever develops more than a very ordinary degree of sweetness.

This cane is undoubtedly very resistant to root disease, but this seems to be its only virtue. It was among the very few kinds which developed no top rot whatever in the Santa Rita immunity test. At



B 4578



B 4596

one time it was recommended as having great resistance to mosaic, but this claim has not been substantiated. It perhaps takes the disease a little less readily than some other kinds, but when attacked it suffers nearly as much as the Rayada. Its resistance to gum disease has not been determined. As a cane for low compacted lands it seems to have no advantage over Yellow Caledonia, and in our tests it invariably falls below this kind in sucrose and purity. It should only be planted for some special object and with these facts in mind.

In Circular 8 its record is third in tonnage out of 25 kinds; total tons, 3 crops, 108 5; brix, 15.03; sucrose, 12.73; purity, 84.2, or an average yield of 3 31 tons of sugar. The Fajardo reports indicate an average of 3 38 tons sugar per acre in 1916–17 and 2.72 tons in 1918–19. At Central Lafayette as plant cane in 1914 it gave, brix, 19.8; sucrose, 17.6; purity, 88.8, which is the highest analysis in our records. Other analyses follow:

Kind	Date	Age	Extr.	Brix	Sucr.	R. S.	Purity	Fiber
B 4596	1-20	Rat 14 mo	65.0	13.27	10.15		76.50	
B 4596	12-20-20	Rat 14 mo	71.0	13.30	9.34	2.31	70.22	11.60
Cristalina	12-20-20	Rat 14 mo	70.0	17.50	15.53	0.28	88.74	9.60
B 4596 (1)	1-14-21	Pl 1 mo	68.7	13.10	9.64	[illegible].41	73.58	10.64
Cristalina	1-14-21	Pl 15 mo	70.0	17.25	15.96	0.37	92.52	9.60
B 4596	4-13-21	Pl 18 mo	68.4	16.00	13.65	1.46	85.31	12.64

(1) Lowest in sucrose out of 40 kinds

A cane of absolutely no promise whatsoever for Porto Rico.

REFERENCES

COWGILL, H. B—Distribución de Caña para Semilla. P. R. Ins. Expt. Station, Cir. 8; 1917.

VEVE, RAFAEL A.—Our Experience with Cane Varieties. Mem. Assn. of Sugar Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922.

B-4934. See Plate XIV, opposite page 125.

Was in cultivation at this Station from 1911 to 1916 The seed came from Central Guánica. It does not seem to have been cultivated elsewhere.

Not seen.

REFERENCES

CRAWLEY, J. T.—Varieties of Canes. Annl. Rept. of the Ins. Expt. Sta., published as Bull. 5, pp. 12–15; Aug., 1913.

WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands, 1919–20. Pt. I, Expts. with Varieties, pp. 1–53; Comm. Agr. for W. I.

B-6032.

Probably imported from Barbados by Central Mercedita of Ponce. Seed was brought to this Station from that Central in fall of 1919. It has been badly attacked by mosaic at Mercedita. This proves to have been Ba-6032, *q. v.*

B-6048. See Plate XIV, opposite page 125.

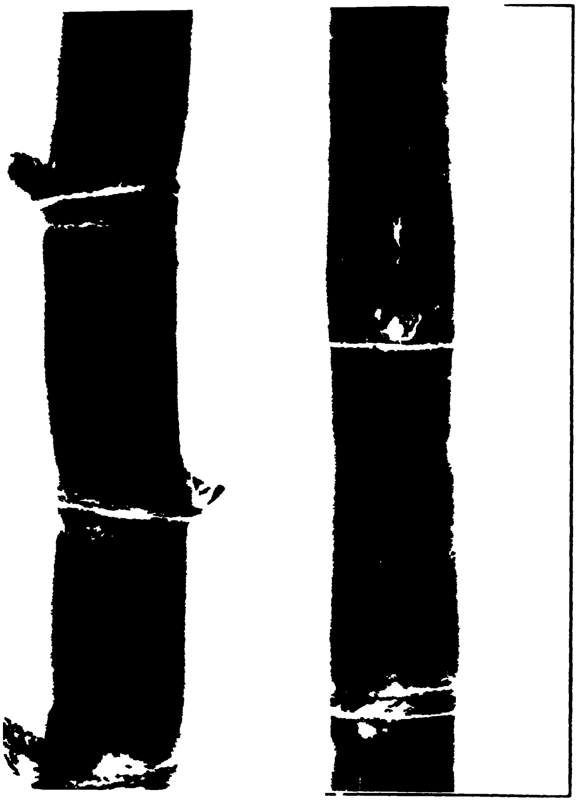
Mr. Sewall notes that this kind came from the Mayagüez Station. It was in cultivation at this Station 1911 to 1916 with seed sent by Mr. Sewall but had disappeared. It was in the experimental plots at Fajardo and seed was again obtained there in November, 1919. In the Santa Rita immunity experiment it was strongly resistant to root disease and developed no top rot but it was quite susceptible to mosaic.

* **B-6292.** See Plate XV, opposite page 127.

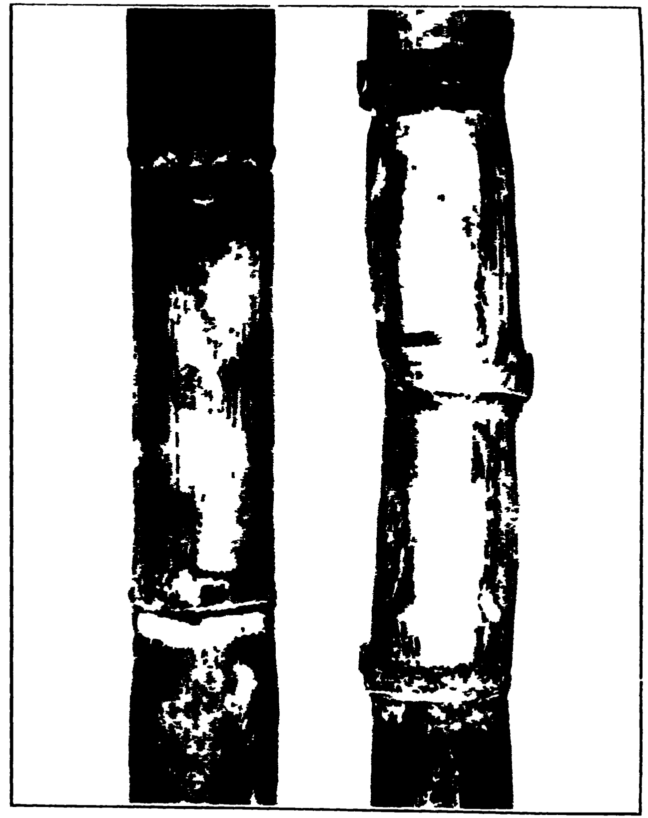
A seedling of T-24. This kind was imported by this Station from Barbados in 1911. It does not figure in the available reports from either Guánica or Fajardo.

Erect or tardily decumbent, vigorous, good stooler, arrows occasionally. Stalks long, medium to medium slender, green with a dull red flush, but little bloom. Internodes medium length, somewhat compressed, inequilateral, slightly tumid on side opposite bud, furrow shallow but evident. Nodes slightly constricted, oblique; growth ring medium width, often slightly elevated, greenish; root band oblique, 6 to 10 mm., greenish; rudimentary roots crowded, whitish, in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band slightly constricted, 8 to 10 mm., well marked Buds broadly ovate, obtuse, sometimes broader than long, about 14 × 14 mm., exceeding the growth ring by one-third, margin broad, about 2 mm., uniform, germination apical or subapical, usually soon developing, with heavy basal placs and abundant marginal and apical vestiture. Leaf sheaths with rather scanty but long and coarse vestiture, green or sometimes a little tinted below, not glaucous; throat often crinkled, lannate, and with scanty marginal hairs; collar reddish brown, glaucous, the margins lannate; ligule about 4 mm., the edge uneven and fiambriate; ligular processes none or small and poorly developed. Leaf blades abundant, flat, spreading, 5 to 6 cm., light green, minutely serrulate, the base even, not ciliate.

This is a valuable kind, especially for *vega* lands. It is not so well adapted to dry hills. It should be planted in the fall as *gran cultura*, since it is slow in maturing. It is adapted to the same conditions as Yellow Caledonia and it may be expected to make equally



B 3859



B 4395

as good tonnage and at full maturity to yield a larger per cent of sucrose.

In the Santa Rita immunity experiment it proved to be about equal to Rayada in root-disease resistance and to be rather more susceptible to mosaic. Its resistance to gum disease has not been determined.

The following items are from the Station records

Kind	Date	Age	Tonnage	Brix	Sucr	Purity
B 6292 (1)	1915	Pl	37 10	16 33	14 75	90 3
Cristalina	1915	Pl	22 10	17 98	16 55	92.2
B 6292 (2)	May 1916	Rat	25 60	18 00	17 2	92 45
Cristalina	May 1916	Rat	18 80	18 8	17 8	94 14

(1) First in tonnage out of 20 kinds

(2) Second in tonnage out of 20 kinds both as ratoon and for two crops

Recent analyses are as follows:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B 6292	12 15 20	Rat 14 mo	70 0	14 93	11 25	2 55	78 70	10 80
Cristalina	12 15 20	Rat 14 m	70 0	17 50	15 54	0 28	88 78	9 60
B 6292	1 24 20	Rat 15 mo	70 9	13 60	10 45	1 52	76 83	11 64
Cristalina	1 24 20	Rat 15 mo	70 3	17 85	16 14	0 [illegible]	90 42	10 69
B 6292	2 7 21	Pl 18 mo	66 8	[illegible]	[illegible]	[illegible]	90 31	12 06
Cristalina	2 7 21	Pl 16 mo	68 6	[illegible] 90	16 11	0 803	90 16	13 81
B 6292	4 11 21	Pl 18 mo	68 5	18 50	17 24	0 50	93 18	11 94
B 6292	1 17 23	Pl 13 mo	Aguirre	20 50	[illegible]		84 40	
B 6292	2 18 23	Pl 14 mo	Aguirre	20 80	17 98		86 50	
B 6292	3 19 23	Pl 15 mo	Aguirre	21 10	18 94		89 80	
B 6292	4 18 23	Pl 16 mo	Aguirre	18 50	[illegible]		[illegible]	
B 6292	Dec 1924	Pl [illegible] mo	Aguirre	19 [illegible]	[illegible] 98		87 [illegible]	
B 6292	Dec 1924	Pl 18 [illegible]	Aguirre	[illegible]	11 [illegible]		[illegible]	

The last two analyses from Aguirre represent factory figures from two *poyal* fields, one of 15 acres at Hacienda Potala and the other of 4½ acres on Hacienda Carmen The first yielded 42 38 tons of cane and 5 31 tons of sugar per acre, while the second produced 58 and 5 96 tons respectively—exceptionally good showings for this type of land Earle in his Aguirre notes states that this is a very good cane for heavy soils, but that it should not be planted in light, sandy soils All new plantings at Aguirre on heavy soils have been reported as doing finely. This is another cane which will stand more investigation and we have it planted in tonnage experiment at the Station on poorly drained *vega* land in comparison with other Barbados seedlings.

REFERENCES

Foss.—Summary of Varietal Results at Central Aguirre, 1924–25.

Veve, Rafael A.—Our Experience with Cane Varieties. Mem. Assn. Sugar Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922.

B-6308.

This seems to have been introduced by Central Mercedita of Ponce. Seed was brought from there to this Station in November 1919. But little attacked by mosaic at Mercedita. It promissed and gave heavy tonnage, but a close study of its characteristics by the writer and Mr. Luis Serrano proved this to be another case of mixed numbers, as the cane we have under this number is typical D-109, which see, while B-6308 is a yellow cane of very distinct botanical and cultural characteristics.

REFERENCES

HALL, R. R., & BOVELL, J. R.—Report on the Sugar-Cane Experiments for the Season 1918-20, Part III. Expts. with Varieties of Sugar Cane. Barbados Dept of Agriculture; 1920.

WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands. Pt. I, Experiments with Varieties of Sugar Cane. Issued by the Comm. of Agriculture for the West Indies; 1921.

B-6341.

Was imported by this Station from Barbados in 1911. It was the lowest in tonnage out of 20 kinds in 1915, but one of the highest in sucrose.

Not seen.

B-6346.

Noted by Cowgill December 3, 1913, as seen in Mr. Sewall's collection at Naguabo. There is no other reference to this cane. (It is possible that B-6436 was intended?)

B-6388.

This cane was in cultivation at his Station from 1911 to 1916 from seed brought from Central Guánica. Its record was poor.

Not seen.

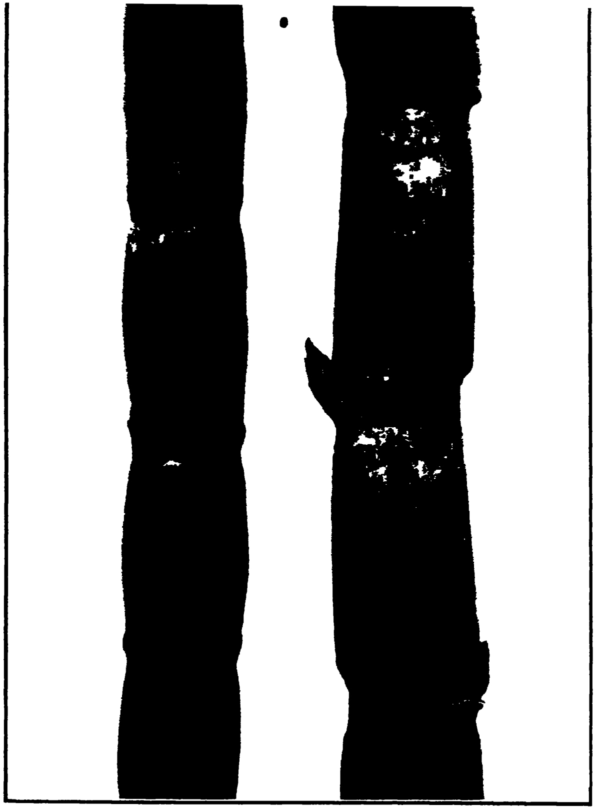
B-6436.

Introduced from Antigua in 1911 by Mr. Sewall. No other record of this cane has been found.

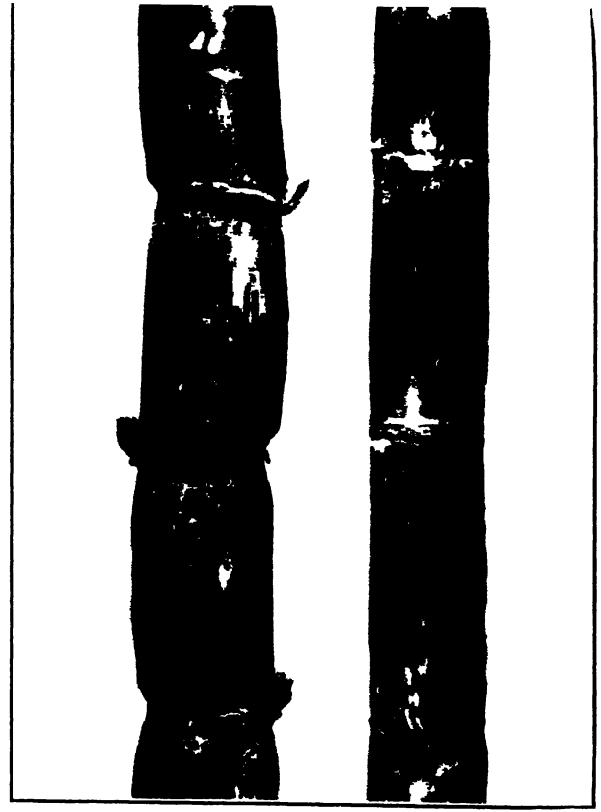
Not seen.

* B-6460. See Plate XV, opposite page 127.

A seedling of T-24. It seems to have been introduced from Barbados by Mr. Murphey. It was not mentioned in his reports from Guánica during 1910, but occurs frequently in his 1911 and 1912 reports. It was planted for a while at Both Guánica and Fajardo and at Central Mercedita, Ponce. It has been sent out from this Station quite widely to different parts of the Island.



B 4934



B 6048

Soon decumbent, vigorous, good stooling, arrows infrequently. Stalks long, medium diameter, green, yellowish on maturity, little or no flush, sometimes checking in lines, some bloom. Internodes medium to long, somewhat tumid, usually enlarged below, more or less staggered, furrow broad but shallow. Nodes constricted, oblique; growth ring broad, elevated, concolorous; root band oblique, 6 to 10 mm., concolorous; rudimentary roots large, closely crowded, whitish, in about 3 rows; leaf scar glabrous or rarely very sparsely ciliate, appressed behind; glaucous band constricted, narrow, 6 to 8 mm., well marked. Buds large, ovate, or ovate-lanceolate, acute, 11 to 12 × 16 to 18 mm., exceeding the growth ring by one-half or more, margin narrow, uniform, germination apical, short, rather scanty basal placs and scanty marginal vestiture of long hairs. Leaf sheath with scanty vestiture of short appressed hairs, green or slightly tinted below, not glaucous; throat narrow, lannate, with scanty marginal hairs; collar narrow, pallid glaucous, the margins lannate; ligule broad at center, reaching 5 mm., the ends tapering rapidly, fiambriate; ligular processes absent or poorly developed. Leaf blades abundant, flat, suberect, 6 to 6½ cm. wide, bright rather dark green, minutely serrulate to the base, scarcely ciliate.

This is a good general-purpose cane that Earle thinks should be more widely planted. It succeeds on a variety of soils and as it matures about with Cristalina it may be planted either in fall or spring.

It is decidedly more resistant to both root disease and mosaic than Rayada and Cristalina. Its resistance to gum disease has not been determined

This cane was noted as one of the three best at Fajardo in 1914, the others being Yellow Caledonia and D–117, but its record as a sugar producer has been only medium at both Fajardo and Guánica, as well as at the Hatillo Fruit farm near Río Piedras. At Guánica it was included by Mr. Murphey in a list of best canes for 1911. In some variety plots at Central Mercedita, Yabucoa, on rich cow-penned land, cut February, 1920, as plant cane at 17 months, it gave, without irrigation, tons per acre, 65.6; brix, 16.30; sucrose, 13.82; purity, 84.8, being second in tonnage but first in sucrose out of 8 kinds. This would represent 6.527 tons sugar per acre. Available analyses are as follows:

Kind	Date	Age	Extr.	Brix	Sucr.	[illegible]	Purity	[illegible]
B-6450 . ..	12-2-20	Pl, 12 mo	70 4	15.80	12.87	2.16	87.75	12.60
Ave. of 5 Cheribou.	12-2-20	Pl. 13 mo.	.....	......	12.69	1.67	85.88	12.39
B-6450 . ..	12-20-20	Rat. 14 mo.	70 2	16.53	14.22	0.21	86.06	8.81
Cristalina .	12-20-20	Rat. 14 mo.	70.0	17 50	15.53	0 26	88.74	8.80
B-6450 . .	2-2-21	Rat. 16 mo	71 6	17.05	15 03	0.56	88.15	9.08
B-6450	2-2-21	Rat. 16 mo.	73 4	15.50	13 43	1.30	86.09	10.64
Cristalina	2-2-21	Rat 16 mo.	70 3	17.85	16.14	0.33	90.42	10.89
B-6450	2-7-21	Pl 16 mo.	70 5	17 25	15 39	0.75	89.21	11.90
Cristalina .	2-7-21	Pl. 16 mo.	68.6	17 90	16 14	0.602	90.16	12.61
B-6450 . ..	1-16-23	Pl 13 mo.	Aguirre	17 55	15 26	....	87 00	....
B-6450 .	2-17-23	Pl 14 mo	Aguirre	19 50	17.74	. . ..	89.10	....
B-6450 .	3-18-23	Pl 15 mo.	Aguirre	19 80	17 56	Tns Cane p. a.	88.50	Tns. Sug. p. a.
B-6450 .	4-17-23	Pl 16 mo	Aguirre	19 90	17 66	.. ..	88.70	....
B-6450 . .	Dec. 24	Pl 17 mo	Aguirre	17 16	14 79	33 43	86 20	3.64
B-6450 .	Dec 24	Pl 17 mo	Aguirre	17 02	14 62	31 52	85 10	3.34
B-6450 .	5-27-26	Rat 18 mo	Ins Sta	19 14	16 98	26 25	88 40	....
H-109	5-27-26	Rat 18 mo	Ins Sta	18 95	16 70	25 00	88.10	....

There is certainly nothing strikingly favorable for B-6450 in any of the above figures—in fact the writer has been unable to find that this cane has distinguished itself anywhere in Porto Rico, despite its popularity at one time and the wide distributon of it made from the Station, apparently without much definite data as to its value under Porto Rican conditions. The showing at Aguirre is very poor indeed as compared with either B-3922 or B-6292. The cane has had a thorough proving in Porto Rico and there seems no reason to predict its continued cultivation on the merits of its results on the "Isle of Enchantment".

REFERENCES

HALL, B. A., & BOVELL, J. R.—Report on the Sugar-Cane Expts. for the Season 1918-20. Pt. III, Expts. With Varieties, pp. 19-77; Government of Barbados.

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—*Ibid*, 1919-21, pp. 26-37.

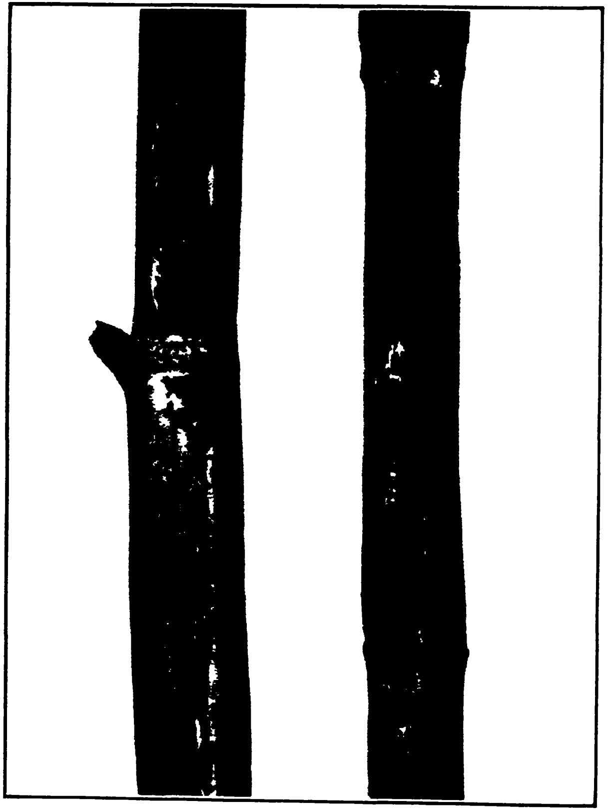
B-6536.

This variety was in cultivation at his Station from 1911 to 1916, from seed brought from Central Guánica. It also occurred in the experimental plots at Central Fajardo and seed from there was again brought to this Station in November, 1919. It was included in the Santa Rita immunity experiment, where it showed medium resistance to root disease and rather strong resistance to mosaic. It is of only moderate vigor and medium sucrose content.

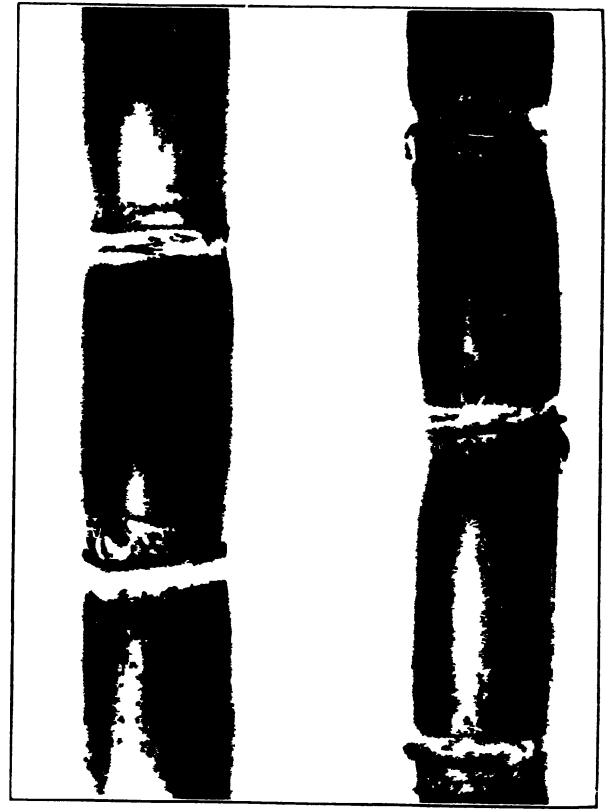
REFERENCES

COWGILL, H. B.—Report of the Plant Breeder. 4th Rept. of the Bd. of Commissioners of Agr. of P. R., 1914-15, pp. 22-23; 1916.

VEVE, RAFAEL A.—Our Experience with Cane Varieties. Mem. Assn. Sug. Tech. of P. R., I, 1, pp. 28-31 (with tables of analyses); June, 1922.



B 6292



B 6450

This was introduced from Barbados by this Station in 1911. It gave poor tonnage but good sucrose.

Not seen.

B-7169. See Plate XVI, opposite page 129.

Introduced by this Station from Barbados in 1911. It occurred in the experimental plots at Fajardo and seed was again brought from there in November, 1919. It is of medium vigor and sucrose content.

REFERENCES

COWGILL, H. B.—A Method of Identification and Description of Sugar-Cane Varieties and its Application to Types Grown in Porto Rico. Jour. of the P. R. Dept of Agr., I, 3, pp. 119–140; July, 1917.

WATTS, FRANCIS.—Sugar-Cane Experiments in the Leeward Islands, 119-20—Pt. I, Expts. with Varieties, pp. 1–53. Issued by Comm. Agr. for W. I.

* B-7245.

Introduced by this Station from Barbados in 1911. It does not seem to have been grown elsewhere on the Island.

Strictly erect, vigorous, medium stooler, no arrows. Stalks medium length and diameter, green becoming yellow, with a red flush, little or no bloom. Internodes medium length, nearly cylindrical but aprubtly shouldered below on side opposite bud, straight, furrow none. Nodes slightly constricted, oblique, growth ring narrow, usually elevated, brownish; root band narrow, oblique, 5 to 8 mm., constricted, concolorous or lighter; rudimentary roots pallid, crowded, in about 4 rows; leaf scar glabrous, usually prominent behind; glaucous band narrow, 5 to 8 mm., well marked, but little constricted. Buds small broadly ovate, obtuse, about 8 to 9 × 8 to 9 mm., not exceeding the growth ring, margin narrow, uniform, usually purplish germination apical, not developing on the standing stalks, short basal placs and sparse vestiture of white hairs on sides and apex. Leaf sheaths with a coarse abundant vestiture of strongly assurgent hairs, green, not glaucous; throat lannate and with a sparing vestiture of rather short white hairs; collar narrow, pallid, reaching the midrib, glaucous and more or less lannate throughout; ligule short, 3 mm., nearly even; ligular processes none. Leaf blades spreading, somewhat 2-ranked , flat, 6 to 7 cm. wide, bright green, minutely serrulate, the base sparingly ciliate.

This is a cane with unusually good keeping qualities in the field. It never arrows, almost never falls down and the buds do not sprout,

making it unusually well adapted to holding over as *caña quedada* or long-season cane. It grows late in the season and consequently is a little late in maturing but reaches nearly average in this respect. It is better adapted to *vega* lands.

Its reaction to the different diseases have not been determined. It is ratooning well and so must be fairly resistant to root disease.

Its early record at the Station is as follows:

Kind	Date	Age	Tons	Brix	Sucr	Purity
B 7245 (1)	1915	Plant	30 0	18 64	17 30	92.2
Cristalina	1915	Plant	22 10	17 98	16 55	92 0
B 7245 (2)	May 1916	Rat	37 80	19 1	18 0	94.24
Cristalina	May 1916	Rat	18 80	18 8	17 8	94 14
B 7245	4 30-19	Rat 11 mo		20 0	18 32	91 61
B 7245	Apr 1920	2nd Rat 12 mo		20 7	18 78	88 88
B 7245	5 18 20	2nd Rat 18 mo		21 [illegible]	16 [illegible]	[illegible] 65
B 7245	1 13 20	2nd Rat 8 mo		14 82	11 19	75 55
Cristalina	1 13 20	2nd Rat 8 mo			16 [illegible]	

(1) Fourth in tons out of 20
(2) First in tons out of 20

The late analyses are as follows:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B 7245	1 19 21	Pl 15 mo	70 0	17 [illegible]	15 11	0 95	87 [illegible]	10 80
Cristalina	1 19 21	Pl 15 mo	70 0	17 25	15 96	0 37	92 52	9 60
B 7245	2 14 2	Pl 16 mo	66 6	15 85	12 93	1 27	81 57	12.02
Rayada	2 14 2	Pl 16 mo	63 6	17 15	15 25	0 81	88 92	12 37
B 7245	2 2 21	Pl 20 mo	70 1	18 [illegible]	16 73	0 71	90 18	13 15
B 7245	4 13 21	Pl 18 mo	70 7	17 90	16 87	0 509	92 18	10 44

REFERENCES

COWGILL, H B.—A Method of Identification and Description of Sugar-Cane Varieties and its Application to Types Grown in Pto. Rico. The Journal of the Department of Agr. of P R., I, 3, pp. 119–40; July, 1927.

ROSENFELD, ARTHUR H.—List of All Sugar-Cane Varieties under Trial at the Ins. Sta. Annl. Rept. of Sta., 1923–24, pp. 63–4

B-8660. See Plate XVI, opposite page 129.

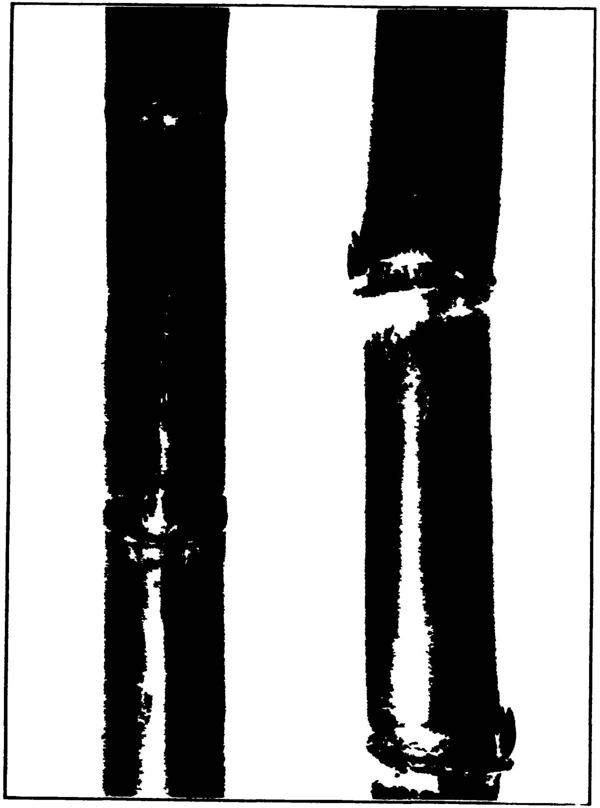
Introduced by this Station from Barbados in 1911. Its record was medium both as to tonnage and sucrose.

Not seen.

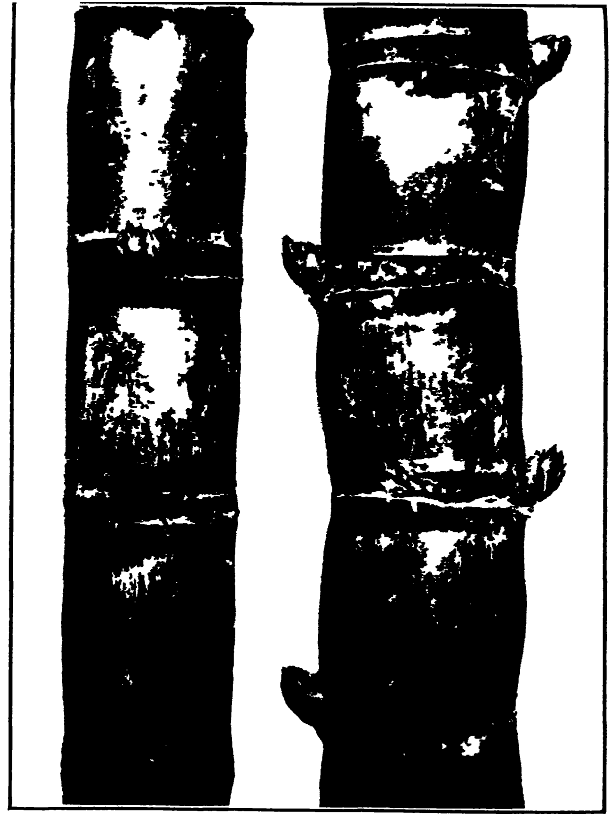
Ba-6032. See Plate II, opposite page 119.

Another one of the varieties obtained from Hon. J. R. Bovell, Director of Agriculture in Barbados, in 1922. Earle reports its introduction by Guánica Centrale in 1919.

Recumbent, good vigor. Stalks long and medium diameter, yel-



B 7169



B 8660

low, becoming heavily flushed with age, large discolored white blotches and striations, some bloom. Internodes medium length, slightly tumid, tendency to split, very staggered, furrow traces to none. Nodes constricted and oblique; growth ring wide, even, brownish green to concolorous; root band wide, oblique and concolorous; rudimentary roots few and scattered, 2–3 in rows, purplish; leaf scar glabrate, appressed behind; glaucous band conspicuously sunken, broad and well defined. Buds large, 11–15 mms., exceeding growth ring by one-third, oval, germination sub-apical, margins wide, purplish, abruptly shouldered at sides forming an urn-like shape, sides covered with short appressed hairs, light basal placs, leaf sheath with very scanty dorsal vestiture of short deciduous hairs, sides glabrate, inner margins heavily stained with purple, glaucous; throat wide, lannate with long coarse hairs at margins, collar narrow, rather inconspicuous, reaching mid-rib, glaucous; ligule medium width, 3-5 mm., nearly even; ligular process 1–2 cms., on one side only. Leaf blades sub-erect with erect tips, wide, 8–10 cms., dark green, margins minutely and uniformly serrulated, with long straggling hairs at base.

This fine-looking cane, which is very similar to B.H. 10(12) in general appearance, but can be easily distinguished from it by its broad, brownish-green growth ring, came to us from Barbados with a most excellent record, but with us on the North Coast has proven a consistently poor germinater and rather a poor ratooner, although on the South Coast, notably at Mercedita de Ponce and at Fortuna, it has given some very good showings as regards tonnage and sucrose content and has germinated well. Aguirre reports it very susceptible to gummosis. On writing to Mr. Bovell, the producer of this cane, in regard to its poor germination on the North Coast, he replied, under date of 12th March, 1925:

> "About the germination of the Ba-6032, I can say that we in Barbados find germination excellent."

On a visit to the Station on 15th May, 1924, Mr. Bovell stated to the writer that this is considered an excellent cane in Barbados, although rather later maturing and not so sweet as B.H. 10–12.

Planted at the Station in 1922 in *vega* land, alongside B.H. 10 (12), it never made growth as plant to compare with the latter and, while stooling fairly well as first ratoons, it was of inferior appearance to the B.H. 10(12) throughout the season. Planted on hill land in November, 1924, it showed very poor germination and was replanted three times without obtaining a perfect stand.

At both the Bayaney substation, on red hill land, and the "Los Caños" substation, on *vega* land of good quality, this variety is showing up very poorly.

The following analyses have been made:

Variety	Age	Location	Tns cane p a	Brix	Sucr	Purity	Tns sugar p a
B-6032	18 mo	Ins Exp Sta		15 40	12 49	81 10	Dec 1920
Cristalina	18 mo	Ins Exp Sta			13 69	85 88	Dec 1920
B-6032	16 mo	Ins Exp Sta		17 90	15 94	89 05	Mar 1921
Cristalina	16 mo	Ins Exp Sta		19 00	17 20	90.02	Mar 1921
B-6032	Retoño	Ins Exp Sta		18 20	16 40	90 11	Mar 1923
Cristalina	Retoño	Ins Exp Sta		20 80	19 92	95 77	Mar 1923
B 6032	18 mo	Ins Exp Sta		15 10	12 67	83 91	Jan 1925
B-6032	G C	Mercedita	63 12	(Cosechada en 1921			6 48
Cristalina	G C	Mercedita	63 50	(Cosechada en 1921			6 81
B 6032	G C	Ins Exp Sta	80 80	16 00	13 40	84 60	2 94
BH10(12)	G C	Ins Exp Sta	54 81	17 48	15 00	86 06	6 05

In the tonnage experiment, cut in Feb. 1926, with B.H. 10(12) for which figures are given above, Ba-6032 stood eighth in sucrose amongst sixteen kinds, giving the smallest production of sugar per acre of all. Hardly seems likely to compete with B.H. 10(12) successfully in Porto Rico, as it appears to be a more delicate cane in every sense.

REFERENCES

LEEWARD ISLANDS—Rept. on Sugar Experiments in 1918.
ROSENFELD, ARTHUR H.—Rep. of the Spec. Technologist Annl. Rept. of the Ins. Expt Sta of P. R., 1924–25.

Ba-7924.

Received from its producer, Hon J R. Bovell, Director of Agriculture in Barbados, in November, 1924 A striking looking, well-developed cane, with a lanceolate bud like S C. 12/4 Planted out in tonnage experiments in October, 1925, it has maintained a consistently better appearance and more vigorous growth than the B.H. 10(12), which is used as a check. Earle reported this cane in cultivation at the Station from seed imported from Barbados by Central Guánica in the fall of 1919, but the writer has been unable to find any record of it at that time

Erect, later recumbent, good vigor, excellent stooler, early and prolific arrower. Stalks long and of good girth, light ashen green, later becoming pinkish brown, very heavy bloom. Internodes long, appressed at sides, staggered, furrow trace to none. Nodes slightly constricted at back opposite bud, oblique; growth ring very broad and elevated, oblique, light green to concolorous; root band medium width, oblique, concolorous; rudimentary roots large, few and scattered, purple, tendency to premature sprouting; leaf scar glabrate,

broad and prominent in front and appressed behind; glaucous band broad and conspicuous, constricted. Buds large, 10–12 mms., exceeding growth ring by one-third, triangular-ovate, germination apical, margins narrow, uniform and glabrate, no apical tufts, light basal placs. Leaf sheaths glabrate, no wax, slightly tinted, inner, base green; throat broad, dark color, sparsely lannated with scattered long hairs at margins; collar broad, well defined, reaching midrib, glaucous; ligule narrow except at center, where it is concave, nearly even, ligular process inconspicuous, deciduous, on one side only. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, with prominent white midrib, uniformly and minutely serrulated, sparse basal ciliation.

REFERENCES

Bovell, J. R., & D'Albuquerque, J. P.—Report on the Sugar-Cane Expts. for the Season between 1920–22. Barbados Dept. Agr.

Idem.—1921–23.

Ba-8069.

One of the canes brought by Mr. O W. Barrett from Barbados in November, 1924. As it was planted out in tonnage experiments only in October, 1925, no data are available as to its indicated value in Porto Rico.

Erect, fair vigor. Stalks long and of medium girth, yellowish becoming reddish pink with exposure to sun, no bloom. Internodes long, almost cylindrical, staggered, no furrow. Nodes slightly constricted, oblique, concolorous; growth ring broad and prominent, yellowish green; root band wide, oblique, yellowish green to concolorous; rudimentary roots small and crowded, 4–6 in rows, purple; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and conspicuous. Buds, large and plump, 9–11 mms., ovate, scarcely exceeding growth ring, germination apical, margins very broad and conspicuous, flat, on upper half only, purple brown, covered with vestiture of ashen hairs which are very characteristic, no apical tufts, light basal placs. Leaf sheaths dorsally lannated, glabrate at sides, glaucous, lightly tinted, inner base also tinted; throat broad and well defined, covered with long, coarse hairs; collar broad and well defined, reaching midrib, lannate; ligule narrow, except at concave center, nearly even, ligular process long, broad and scimiter-shaped, on one side only. Leaf blades spreading with declining tips, medium to broad, 6–8 cms., dark green, white midrib, margins serrulated on upper two-thirds basal ciliation.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Report on the Sugar-Cane Expts., 1922–24. Barbados Dept. of Agriculture.

ROSENFELD, ARTHUR H.—Rept. of Spec. Technologist. Ann. Rept. P. R. Ins. Expt. Sta. 1924-25.

Ba–8409.

Sent by the producer of this variety, Hon. John R. Bovell, Director of Agriculture in Barbados, at request of Commissioner of Agriculture Carlos E. Chardón, in November, 1924. Planted out in tonnage experiments in October, 1925, does not seem to have as good general vigor and development as B.H. 10(12), which is used as a check.

Erect, at length recumbent, fair vigor. Stalks long and of good girth, light ashen green, later becoming brownish pink, heavy bloom. Internodes long, appressed at sides, staggered, furrow broad and very shallow. Nodes slightly constricted and oblique; growth ring wide, elevated, oblique, yellowish green to brown; root band wide in front and very narrow behind, concolorous; rudimentary roots small, few and scattered, 3–4 in rows, purple, leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, medium width and conspicuous on young joints. Buds large, 9–11 mms., plump, exceeding growth ring by one-third, lanceolate, germination apical, margins flat, medium width almost to base, scantly lannated, no apical tufts, heavy basal placs. Leaf sheaths subglabrate, little wax, slightly tinted within and without; throat medium width, lannated with coarse long hairs, long tufts at margin; collar broad and well defined, reaching midrib, lannate; ligule medium width, nearly even, ligular process broad and long, scimiter-shaped, deciduous and on one side only. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, uniformly and minutely serrulated, sparse basal ciliation

REFERENCES

BOVELL, J. R. & D'ALBUQUERQUE, J. P.—Rept. on Sugar-Cane Expts., 1921–23. Barbados Dept. of Agr.

Idem. –1922–24.

Ba–11403

Sent by the producer of this variety, Hon. John R. Bovell, Director of Agriculture in Barbados, at request of Commissioner of

Agriculture Carlos E. Chardón, in November, 1924. Planted out in tonnage experiments in October, 1925, does not seem to have as good general vigor and development as B.H. 10(12), which is used as a check.

Erect, at length recumbent, good vigor. Stalks long, medium girth, greenish yellow, becoming dark red and purple on exposure to sun, narrow, long, discolored, vertical striations, heavy bloom. Internodes long, rather tumid, staggered, no furrow. Nodes constricted and oblique; growth ring narrow, 2–4 mms., even, concolorous and inconspicuous; root band narrow; oblique, concolorous; rudimentary roots inconspicuous, few and scattered, 3–5 in rows, concolorous; leaf scar glabrate, appressed behind; glaucous band constricted, narrow and inconspicuous. Buds medium size, 8–10 mms, ovate-lanceolate, scarcely exceeding growth ring, germination apical, margins flat, rather broad, purplish, scantly lannated, same lannation along fibro-vascular bundles, sparse apical tuft of long, white hairs, heavy basal placs. Leaf sheaths subglabrate, some wax, lightly tinted within and without, throat indistinct, lannate, with long straggling marginal hairs; collar wide, well defined, reaching midrib, glaucous; ligule narrow, becoming wider and peaked at center, nearly even, ligular process 2–3 cms., in length on one side only. Leaf blades erect with declining tips, medium width, about 6 cms., distinct white midrib, dark green, minutely and uniformly serrulated to base, scant basal ciliation.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Rept. on Sugar-Cane Experiments for the Season between 1919–21.—Barbados Dept. Agr. *Idem.*—1920–22.

Ba-11569. See Plate II, opposite page 119.

One of the three most promising canes in Barbados when it was obtained through the courtesy of Director of Agriculture John R. Bovell in 1922.

Erect, at length recumbent, good vigor. Stalks long and medium girth, yellow with long discolored white striations and some blotches, slight flush, some bloom. Internodes long, cylindrical, but slightly enlarged at base, somewhat staggered, no furrow. Nodes slightly constricted; growth ring broad and elevated, oblique, bright red to concolorous; root band wide, oblique and concolorous; rudimentary

roots crowded, inconspicuous, 3–5 in rows; concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds, large, 11–15 mm., not exceeding growth ring, orbicular, germination subapical, margins wide and covered with short appressed hairs, very light basal place. Leaf sheaths with scanty dorsal vestiture of short deciduous hairs, sides glabrate, slightly glaucous, inner base heavily stained with purple; throat rather narrow and well defined, with short appressed hairs at margin; collar narrow and well defined, reaching midrib, glaucous; ligule narrow 2–4 mm., nearly even; ligular process none. Leaf blades erect with declining tips, broad, 8–10 cms., dárk green, margins uniformly and minutely serrulated, very sparsely ciliated at base.

This exceptionally good-looking cane has for several years been the rival of the famous B.H. 10(123) in the land of its birth. For instance D'Albuquerque reports that for the season 1923–25, in nine experiments with plant canes on black soils, Ba–11569 produced an average of 8,357 pounds sucrose per acre, while B.H. 10(12), under identical conditions, produced 8,019. On red soils as plant cane in four experiments, B.H. 10(12) averaged about one-half ton sugar more than the Ba–11569. This was the case, also, in three experiments with first ratoons on red soils, but, in an experiment with second ratoons on the same kind of soil, Ba–11569 was in the lead by about a quarter of a ton of sucrose.

The cane came to us, therefore, with a most excellent record, but on the North Coast it has proven a consistently poor germinater and not a particularly good ratooner, although inquiries to Mr. Bovell resulted in a statement that in Barbados the germination of this cane had been found to be "excellent". On the South Coast of Porto Rico, notably at Mercedita de Ponce and Aguirre, it has given rather a better account of itself as regards tonnage and sucrose and has germinated consistently well, indicating, that it is more at home under the conditions of the South Coast, despite the fact that it does best on black land in its native home.

Planted at the Station in 1922 in *vega* land, alongside B.H. 10 (12), it never made growth as plant to compare with the latter and, while stooling fairly well as first ratoons, was of inferior general appearance to the B.H. 10(12) throughout the season. As second ratoons it hardy stooled at all, whereas the B.H. 10(12) alongside produced a very good crop. Planted on red hill land in November, 1924, at the Station, it showed very poor germination indeed and

was replanted three times without a perfect stand being then obtained, there still being some 20 per cent of misses. A small field of this variety was planted by Mr. W. C. Dreier, manager of the Hatillo Fruit Farm, near Trujillo Alto, on dark upland soil and only about a 25 per cent germination was obtained. After the plat was concentrated by transplanting the stools the development was still very poor.

At both the Bayaney substation, on red hill land, and the "Los Caños" substation, on *vega* land of excellent quality, this variety is showing up very poorly.

The following analyses have been made:

Location	Date	Age	Mill	Tns. cane per acre	Brix	Sucr.	Purity	Tns sugar per acre
Ins. Expt. Sta.	XI-7-24	11 mos.	Hand	.. ..	14 90	11.97	80 84	....
Cent. S. Jean, Caguas.	V-25-25	17 mos.	Cent.	...	20 20	18 86	93.30	... .
Ins. Expt. Sta.........	II-9-26	16 mos	Cent	35.14	16 92	15 00	89 40	3.94
BH10(12)	II-9-25	16 mos	Cent.	54 81	17 43	15.00	86.06	6.05

In the tonnage experiment with B.H. 10(12), for which figures are given above, Ba-11569 stood fifth in sucrose content amongst sixteen kinds, but was ninth in production of sugar per acre. Another cane which seems hardly likely to successfully compete with B.H. 10 (12) in Porto Rico, where it seems to be a decidedly more delicate cane in every respect.

REFERENCES

RICHARDSON KUNTZ, P.—Annl. Rept of the Div. of Agronomy for the Fiscal Year of 1922 to 1923. Annl. Rept. of the Ins. Expt. Sta. of Porto Rico, 1922–23, pp. 35–45. 1924.

ROSENFELD, ARTHUR H.—Annl. Rept. for the Year 1923–24. *Idem.* —1923–24.

Ba-12079.

This variety has turned out to be about the second poorest of the fifteen Barbados varieties sent by Director of Agriculture John R. Bovell at the request of Hon. Carlos E. Chardón, Commissioner of Agriculture for Porto Rico and brought over by Agricultural Adviser O. W. Barrett in November, 1924. Planted out in tonnage experiments in October, 1925, there has as yet been no time for obtaining definite data as to yields and manufacturing value.

Erect, fair vigor, good stooler. Stalks long and rather slender, greenish yellow, heavily overlaid with dark wax deposit, some flush.

Internodes medium length, tumid and very staggered. Nodes distinctly constricted under bud, oblique; growth ring narrow and inconspicuous, even except for a slight elevation at back opposite bud, concolorous; root band narrow, oblique, concolorous, with heavy black wax deposit, rudimentary roots few and inconspicuous, large, concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band rather constricted, narrow and inconspicuous, on older joints Buds medium to large, 9–11 mms., plump, exceeding growth ring by one-third to one-half, triangular-lanceolate, germination apical, margins wide and flat, purplish, abruptly shouldered near base, subglabrate, no apical tufts, basal places light. Leaf sheaths with abundant dorsal vestiture of short, tawny, deciduous hairs extending to sides, green, inner base heavily tinted with purple; throat narrow and very sparsely lannated, with few long, straggling hairs at margins; collar rather narrow, glaucous; ligule medium width, almost even, ligular process none. Leaf blades spreading with declining tips, medium width, 6–7 cms, dark green, minutely and uniformly serrulated, very sparse basal ciliation

REFERENCES

BOVELL, J. R & D'ALBUQUERQUE, J P—Rept on Sugar-Cane Expts, 1921–23. Barbados Dept. Agr.

Idem.—1922–24.

* BH-10(12). See Plate XVII, opposite page 137, also Plate XVIII, opposite page 139

Seedling of B-6835

Imported by Central Guánica from Barbados in the fall of 1919. Part of this seed also sent to this Station It also seems to have been imported independently by Central Mercedita of Ponce.

Erect, or at length somewhat declined, vigorous, a strong stooler, seldom arrows Stalks long, medium to medium slender, greenish but soon flushing to a uniform dull pink, marked with lines Often blotched, considerable bloom. Internodes medium length, staggered, somewhat compressed, larger below and shouldered on side opposite bud. Nodes constricted, oblique; growth ring rather broad but indistinct, enlarged on the shoulder behind; root band oblique, 6 to 10 mm., concolorous but paler, tapering downward, rudimentary roots small, purplish, in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band slightly constricted, about 8 mm., somewhat obscured by the bloom of the internode Buds nearly orbicular, 10

PLATE XVII

TYPICAL STOOL OF B H. 10(12)

to 11 × 10 to 11 mm., only slightly exceeding growth ring, margin narrow, uniform, often purplish, germination subapical, basal places, and sparse marginal and apical vestiture. Leaf sheaths with a sparse vestiture of short appressed hairs, green or little tinted, somewhat glaucous; throat narrow, lannate with a sparse marginal vestiture of long hairs; collar narrow, scarcely reaching the midrib, glaucous; ligule, about 3 mm., margin undulate, not fiambriate; ligular processes small and poorly developed or none. Leaf blades, suberect, the tips declined, flat, about 6 cm., widest above the middle, light green, minutely serrulate, the base even, not ciliate.

This famous Barbados hybrid has made a very favorable showing. It has proved to be adapted to a wide range of conditions and has even done well on the red shale hills. It is a good germinator and ripens sufficiently early to be used either for fall or spring planting. It ratoons very strongly. It is an unusually good general-purpose cane.

Its resistance to root disease is evidently good. It readily contracts the mosaic but resists its effect rather better than Cristalina, Rayada or S.C. 12/4, while its resistance to gum disease also seems more pronounced than with those varieties. At Santa Rita it has suffered rather heavily from leaf spot, also at Bayaney.

A small field of this cane at Central Mercedita cut early in the crop of 1921, as plant cane of 11 months gave over 6 tons of sugar per acre, which is an unusually good showing for such young cane. Earlier analyses were as follows:

Kind	Date	Age	Extr	Brix	Sucr	R S	Purity	Fiber
B H-10 (12)	12-2-20	Rat 13 mo	65 9	16 53	13 93	1 38	82 2	10 27
Ave of 5 Cheribon .	12-2-20	Rat 13 mo			13 69	1 67	85 88	12 29
B H-10 (12)	1 10-21	Rat 14 mo	68 1	17 40	15 64	0 58	89 88	10 93
Cristalina	1-10-21	Rat 14 mo	71 4	17 30	15 31	0 64	86 67	12 01
B H 10 (12)	2-23-21	Rat 15 mo	66 6	17 10	15 03	1 01	87 89	11 85
Cristalina	2-23-21	Rat. 15 mo	71 4	18 90	17 40	0 30	92.06	12.58
B H-10 (12) ...	2-11-21	Pl 16 mo	70 7	18 00	15 17	1 42	84 27	11 72
Rayada	2-11-21	Pl 16 mo	63 6	17 15	15 25	0 81	88 92	12 97
H B-10 (12)	4-18-21	Pl 18 mo	70 3	18 50	16 71	0 82	90 32	11 88

The following six tables give its condensed history in its country of origin and in some of the other West Indian islands.

TABLE I

CONDENSED COMPARATIVE RESULTS IN BARBADOS

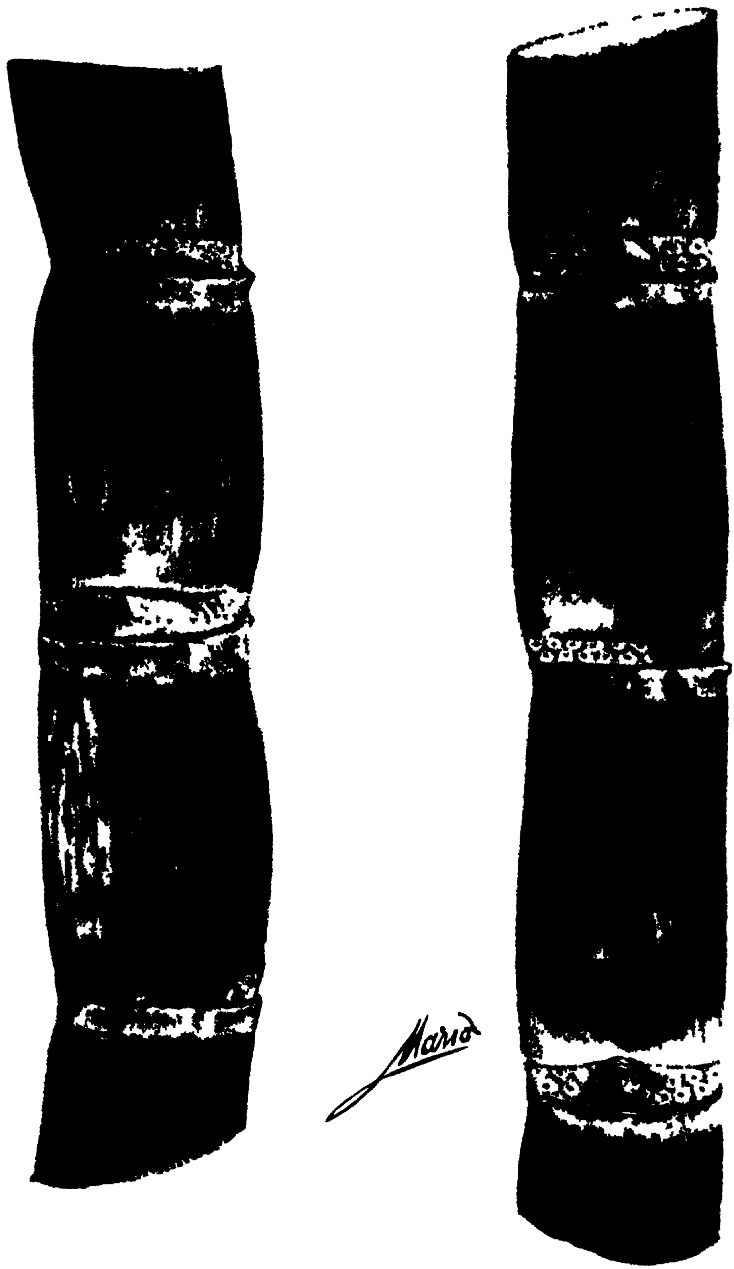
Variety	Tons Cane per acre	Normal Juice					Lbs. Suc. per acre
		Suc.	Gluc.	S. N. S.	Purity	Glucose Ratio	
I. PLANT CANES ON COVERLY PLANTATION—MERIBA FIELD							
W. Transparent................	30.67	2.09	.086	.174	88.92	4.13	8,829
B. H. 10 (12)....................	36.83	2.36	.060	.180	90.77	2.57	11,589
II. PLANT CANES ON WATERFORD PLANTATION—TENNANT FIELD							
W. Transparent................	43.08	2.01	.058	.128	91.55	2.88	11,417
B. H. 10 (12).	52.54	2.25	.052	.124	92.86	2.30	15,594
III. PLANT CANES ON DODD'S PLANTATION—UPPER CHAPEL FIELD							
W. Transparent................	26.44	1.94	.086	.204	87.00	4.43	6,862
B. H. 10 (12)......	47.57	2.37	.046	.154	92.22	1.94	14,879
IV. MEAN RESULTS FOR THREE SEASONS ON DODD'S PLANTATION—UPPER CHAPEL, CAT HOLE FIELDS							
W. Transparent................	25.08	2.08	.074	.... .	88.86	3.70	6,842
B. H. 10 (12)............	39 31	2.33	.073	.. .	91.17	3.13	12,265
V. DUPLICATE FIELDS ON COVERLY AND WATERFORD PLANTATIONS—FOUR EXPERIMENTS							
W. Transparent................	36.87	2.05	.072	.. ...	90.23	3.50	10,126
B. H. 10 (12)....................	44.68	2.80	.056	... .	91.56	2 44	13,583

TABLE II

COMPARATIVE RESULTS FROM GENERAL PLANTINGS OF D-625 AND BH 10(12) IN BRITISH GUIANA FROM RETURNS SUPPLIED BY MANAGERS

	D—625	B. H. 10 (12)
Mean of all plantations.	1.80	2.05
Maximum reported..	2.85	3.04
Minimum reported...	0.28	1.24

PLATE XVIII



BARBADOS HYBRID 10 (12)

TABLE III

AVERAGE RESULTS FOR PLANT AND STUBBLE CROPS IN ANTIGUA, B. W. I.

Age	Variety	Tons Cane per Acre	Gallons Juice per Acre	Lbs. Suc. in Juice
Plant......	White Transparent..	14.73	1,460	3,000
Plant........	B. H. 10 (12)	17.82	1,640	3,800
Ratoons......	White Transparent..........................	10.83	1,040	2,280
Ratoons......	B. H. 10 (12)	11.48	1,210	2,910

TABLE IV

AVERAGE RESULTS FOR PLANT AND STUBBLE CROPS ON ST. KITTS, B. W. I.

Age	Variety	Tons cane per acre	Gallons juice per acre	Lbs sucrose in juice per acre
Plant..........	White transparent	21.0	2560	5840
Plant....	B. H. 10(12).. ...	26 9	2960	6600
Ratoons......	White transparent.	.. ..	.. ..	4910
Ratoons......	B H. 10(12)	.. ..	... .	9170

TABLE V

AVERAGE RESULTS FOR PLANT CANE IN 1919-20 AND AS MEAN FOR ALL SEASONS ON ISLAND OF NEVIS, B. W. I.

Season	Variety	Tons cane per acre	Gallons juice per acre	Lbs sucrose in juice
1919-20 .	White transparent	19.0	1,810	3,570
	B. H. 10(12).	21.0	2,110	4,490
Mean of all	White transparent .	. . .	.	4,000
	B. H. 10(12).	... .	.. . . .	5,360

TABLE VI

FARRELL'S EXPERIMENT PLAT, MONSERRATE, B. W. I.

Age	Variety	Tons per acre	Data on juice: Extr	Gals. per acre	Sucrose per acre	Purity	Lbs. sucr. per acre
Plant......	White transparent .	21.8	60 50	2,750	1 849	92.1	5,090
	B. H. 10(12) .. .	24 2	61 25	4,350	1 907	92 6	8,690
Ratoons...	White transparent.	9 3	......	.. ..	....	.	. .. . .
	B. H. 10(12).........	18 1	..	. ..	....	... ...	... ...

The following tables give some recent large-scale results in Porto Rico, where it is now the most extensively planted cane:

TABLE VII

COMPARATIVE YIELDS ON THE SOUTH COAST FOR THE CROPS 1921-22 INCLUSIVE

Variety	Acres	Age	Tons per acre Cane	Tons per acre 96 Sugar	
I CROP OF 1921					
B. H. 10(12)	4.75	Prim.	58 38	7.27	
Cristalina	80.00	G. C.	52.50	6.81	
B H. 10(12)	29.00	Prim.	17 24	6.75	
Cristalina	36.00	G. C.	48.88	6.88	
S. C. 12(4)	14 50	G C.	62 33	8.30	
Cristalina	86.00	G. C.	47.88	6.05	
II. CROP OF 1922					
S. C. 12(4)	17 00	Prim.	37.52	5.18	
B. H. 10(12)	75 00	Prim.	28.19	4.25	
B. H. 10(12)	4.00	G C	45.69	6.35	
B-208	1 75	G. C	57.10	6.06	
B. H. 10(12)	4 25	G. C.	82.85	10.99	
D-109	6.50	G. C	74 86	8.71	Planted after cowpeas

TABLE VIII

BH-10(12) AT CENTRAL SANTA JUANA

Car No.	Brix	Sucrose	Purity	Factory Yield
1.	23.4	22 16	94.7	16.70
2.	22.0	20 97	95.3	15.90
3.	22 9	21.46	93.7	16.15
4.	22.6	21.32	94.3	15.13

These tables are taken from the work by the author on the B.H.-10(12) and S.C.-12/4 canes, to which the reader is referred for details as to age of cane, time of cutting, etc., etc., as well as for a discussion of the present and future prominent place taken by this exceptionally fine cane in the economy of the Porto Rican sugar industry. Additional data on the yields of this variety may also be found under St. Croix-12/4, *q. v.*

Resuming, this is the outstanding variety of Porto Rico today and one of the prominent varieties of the entire sugar-producing world. It seems destined within a very few years to occupy the

larger part of the cane area of the Island, with S.C.-12/4 taking second place.

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BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Report on the Sugar-Cane Expts, for the Season 1914–16, pp. 15–80; 1916. (Also all later repts.)
ROSENFELD, ARTHUR H.—The B.H. 10(12) and S.C. 12(4) Canes. The Journal of the Dept. of Agriculture of P. R., IX, 3, pp. 215–47; July, 1925.

BSF-12(34).

Reported by Earle to have been introduced by Central Guánica from Barbados in the fall of 1919. Not seen.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Report on the Sugar-Cane Expts. for the Season between 1920–22. Pt. III, Expts. with Varieties.
Idem.—Ibid, 1921–23.

BSF-12(45).

Reported by Earle to have been introduced by Central Guánica from Barbados in the fall of 1919. Not seen.

REFERENCES

BOVELL J. R., & D'ALBUQUERQUE, J. P.—Report on the Sugar-Cane Expts. for the Season between 1920–22. Pt. III, Expts. with Varieties. Government of Barbados.
Idem.—Ibid, 1921–23.

BSF-12(48).

Sent by the producer of this variety, Hon John R. Bovell, Director of Agriculture in Barbados, in November, 1924. Planted out in tonnage experiments in October, 1925, this variety in appearance at least is superior to B.H. 10(12), which is used as the check.

Erect, good vigor, excellent stooler. Stalks long and rather slender, green, changing to uniform wine color, no bloom. Internodes medium length, slightly tumid, staggered, furrow slight to none. Nodes slightly constricted, oblique; growth ring narrow, even, inconspicuous, concolorous; root band narrow, oblique, concolorous; rudimentary roots inconspicuous, large, few and scattered, 2–3 in rows, reddish; leaf scar glabrate, appressed behind; glaucous band constricted, narrow and inconspicuous. Buds medium size, 8–10 mms., plump, ovate, scarcely exceeding growth ring, germination apical, margins narrow, abruptly shouldered at base, subglabrate, no

apical tufts, heavy basal places. Leaf sheaths with scanty dorsal vestiture of short white hairs, sides glabrate, no wax, green within and without; throat broad and split, very sparsely lannated, few coarse hairs at margins; collar broad and reaching midrib, glaucous; ligule medium width, 2–3 mms., nearly even, no ligular process. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green with broad white midrib, serrated on upper two-thirds, scant basal ciliation.

REFERENCES

Bovell, J. R., & D'Albuquerque, J. P.—Rept. on Sugar-Cane Expts. for the Season 1918–20. Barbados Dept. of Agriculture.
Idem.—1919–21.

BSF-12(50). See Plate II, opposite page 119.

Sent by the producer of this variety, Hon. John R. Bovell, Director of Agriculture in Barbados, in November, 1924. Planted out in tonnage experiments in October, 1925, this variety in appearance at least is superior to B. H. 10(12), which is used as the check.

Erect, good vigor, fine stooler. Stalks long, good girth, green to dull yellow, sparse vertical, parallel striations on upper parts of joints, little flush and bloom. Internodes long, enlarged at base, staggered, furrow trace to none. Nodes nearly even, oblique; growth ring medium width, 2–3 mms., elevated, reddish brown, later concolcrous, root band narrow, oblique, concolorous; rudimentary roots large, few and scattered, in 3–4 rows, reddish; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band broad, constricted and conspicuously dark. Buds large, 10–12 mms., exceeding growth ring by half, triangular lanceolate, germination apical, margins narrow, uniform, abruptly shouldered at base, glabrate, no apical tufts, heavy basal placs. Leaf sheaths with scanty dorsal vestiture of short, white, deciduous hairs, sides glabrate, no wax, light green within and without; throat broad, lannate, with dium width, 2–3 mms., nearly even, ligular process none. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, minutely and uniformly serrulated at margins, no basal ciliation.

REFERENCES

Bovell, J. R., & D'Albuquerque, J. P.—Rept. on Sugar-Cane Expts. for the Season 1918–20. Barbados Dept. of Agriculture.
Idem.—1919–21.

BSF-13(8).

Reported by Earle as having been introduced from Barbados by Guánica Centrale in the fall of 1919. Not seen.

REFERENCES

BOVELL, J. R. & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1920–22. Pt. III, Expts., with Varieties.
Idem.—Ibid, 1921–23.

BSF-13(14).

Reported by Earle as having been introduced from Barbados by Guánica Centrale in the fall of 1919. Not seen.

REFERENCES

BOVELL, J. R. & D'ALBUQUERQUE, J. P.—Rept. on the Sugar-Cane Expts. for the Season between 1920–22. Pt. III, Expts., with Varieties.
Idem.—Ibid, 1921–23.

Bengala.

Mentioned by López Tuero (p. 9). He says:

"Very much like Creole, with short, slender joints, juicy, very sweet, leaves strictly erect. But little cultivated, as it is easily attacked by insects. It is originally from Calcutta."

We have no other knowledge of this kind.

Bois Rouge.

(=Palo Rojo). Stahl (p. 136):

"This cane has given admirable results in Mauritius and Bourbon, but here it is feeble and slender. The buds sprout easily on the standing cane, causing it to dry up."

López Tuero (p. 9) calls it Palo-rojo and speaks of it in almost the same words. It was introduced by Dr. Grivot Grand-Court prior to 1879, probably from Guadaloupe.

No canes have been found that can be connected with this name, though at least two unnamed slender red canes are in the Station collections.

Bois Rouge Blandee.

(=Palo Rojo Claro). Stahl (p. 136):

"Color between light and dark; joints short, somewhat barrel-shaped, robust, and resist the disease. It seems to be one of the most valuable varieties for infested lands."

We have no further knowledge of this kind. It probably came from the French islands. At least the name occurs in the literature in conection with Reunion.

Borbon.

(= Bourbon.) Both Stahl and López Tuero consider this distinct from the Otaheite though somewhat closely resembling it. Stahl says:

"Closely resembles Caña Blanca; when young it is spotted with red but later is yellowish green; very rich in sugar; should be planted only one seed in each hole, since it suckers abundantly; in every respect superior to Caña Blanca but it contracts the disease (epidemic of 1872) and should only be planted in districts free from it."

A cane known by this name was found in a colonia near Bayaney. When cultivated at the Station it proved identical with the cane grown at Coloso as Penang. It is quite certain that more than one cane has been included in the group sometimes known as Bourbon and sometimes as Otaheite, but to which one the name Bourbon properly belongs it will be difficult or perhaps impossible to determine.

Calancana.

(= Carandalí, = Imperial del Brasil, = Green Ribbon) Stahl 134, López Tuero 9 Imported from Cuba prior to 1877 by Patxot, Castello & Cía, of Cabo Rojo.

This cane seems quite clearly to be only a color variant of Otaheite (which see for further description), although this view has not been expressed in the literature[1] In this form the stalks and leaf sheaths are striped with green and white. On some soils, especially on full exposure, the white flushes to a delicate pink. It is strikingly handsome cane, but it seems to have all of the cultural disabilities of the self-colored form, and so far as we know it is equally susceptible to all kinds of diseases Its reputation as a very sweet cane is not borne out by the following analyses as compared with Cristalina on same date from same field:

		Arrows	Extr	Brix	Sucro	Red Sug	Puri	Fiber	Age
11-29-20	Calacana	No	70	13.37	9.42	4.84	70.45	12.2	18 mo
11-29-20	Cristalina	No			18.69	1.67	85.88	12.01	18 mo
1-10-21	Calacana	No	68.8	15.60	12.77	1.50	81.85	12.18	12 mo
1-10-21	Cristalina	No	71.3	17.90	15.84	0.64	88.67	12.29	12 mo
2-9-21	Calacana	No	67.6	15.25	12.29	1.64	80.45	12.96	15 mo
2-9-21	Cristalina	No	68.6	16.20	18.85	0.95	85.49	11.20	15 mo

[1] Earle found a stool of Calancana with two stalks that had reverted to a solid green color and that are absolutely indistinguishable from Otaheite

This cane is somewhat widely scattered in mixed planting, but it nowhere exists in pure cultures. There seems to be no reason for its further planting.

Cavengerie. See Plate II. opposite page 119.

(= Caña Colorada, = Caña Francesa, = Rosita, all local names.) Imported by Dr. Grivot Grand-Court of Mayagüez, probably from the French islands, prior to 1878. It now occurs widely in mixed plantings and often nearly pure cultures in the northern and eastern districts, more especially in hill lands.

Habit erect very vigorous, strong stooling, seldom or never arrows. Stalks medium diameter, tall, dark wine color with faint bronze stripes; no bloom. Internodes medium to long, straight or slightly staggered, cylindrical or slightly larger below, furrow faint, usually evident but sometimes wanting. Nodes narrow, only slightly constricted; growth ring conspicuous, usually swollen at first yellowish then dark purple; root band narrow, 6 to 8 mm., concolorous; rudimentary roots inconspicuous, purplish, in 2 to 3 rows; leaf scar glabrous, narrow, somewhat oblique; glaucous band narrow, 6 to 8 mm., at first well marked. Buds ovate, medium size, about 10 to 12 × 10 to 12 mm., exceeding growth ring, margin narrow, uniform, germination apical, base sparingly appressed ciliate, sides and apex glabrous. Leaf sheaths with dense vestiture of short asurgent bristles, tinted, somewhat glaucous, marked with white or sometimes white and pink stripes; throat lannate, and with abundant medium short brownish hairs, especially on the shoulders; collar broad, dark conspicuous, densely lannate toward the margins; ligule narrow, 3 to 3½ mm., margin nearly even; ligular processes, none. Leaf blades erect, the tips declined, dark, green, medium width, about 6 cm., minutely but sharply serrulate to the base, not ciliate.

This is a cane of great vigor and very heavy tonnage and it is a very strong ratooner. It is resistant to drouth and is particularly adapted to the red shale hills of the interior and to the red coral lands of the north coast. It is comparatively low in sucrose and is very late in maturing. It is this latter feature in particular that has made it so unpopular with the mills that some of them refuse to receive it. Occurring as it usually does in mixed plantings, it is almost always cut too green and comes to the mill with very little available sugar. Analyses of 12-month ratoons made at the Station in February 1915 show as little as 6.77 per cent sucrose and only 60.5 per cent purity. Such cane is evidently valueless and it is a folly to cut it and send it to the mill. This only emphasizes the necessity for separating the varieties in pure cultures so that each

may be cut when fit to grind. In the tests at this Station published in Circular 8, 1917, it stood second in a total tonnage for three cuttings out of 25 kinds, being only surpassed by D–625.

	Total ton 3 cut.	Brix.	Sucr.	Purity
Cavengerie	121.48	16.77	12.45	75.8
D-625	139.75	15.26	11.59	73.1
Cristalina	77.52	16.60	15.02	90.5

There is nothing in this report to indicate the stage of maturity at which these canes were cut. Evidently both Cavengerie and D–625 were quite green, still their tonnage was so much greater than Cristalina that the total yield of sugar per acre was much greater. At Fajardo in crop of 1918–19 this cane as second ratoons gave a yield of 48.75 tons cane and 4.64 tons sugar per acre. Only one other analysis is available.

5-6-21	Age	Arrows	Extr.	Brix.	Sucr.	R. S.	Purity
Cavengerie	Pl. 17 mo.	No	66.6	18.17	16.02	1.23	88.20
Cristalina	Pl. 17 mo.	No	65.1	19.55	18.93	.241	96.82

The considerable percentage of reducing sugar shows that the Cavengerie even at this age was still immature.

It seems clear that a cane having such vigor and being so well adapted to conditions where other kinds fail should not de discarded, as is being so frequently urged, until its adaptability to the needs of Porto Rican agriculture is much more fully tested. Most certainly it should not be planted in mixed cultures. *Gran cultura* should not be cut under 18 months. Late spring plantings and late ratoons should be carried over as *caña quadada* until the second season. Handled in this way, this cane will doubtless be more profitable on high, dry lands than the richer kinds now usually planted.

This cane is exceedingly susceptible to mosaic and is often killed outright when attacked. It is quite resistant to the ordinary forms of root disease and so ratoons freely for many years. It is however, freely attacked by the vascular bundle fungus. In fact, this parasite was first detected in this kind. One of its chief merits at the present time is its strong resistance to gum disease. It is not absolutely immune, since stalks have been found with a few vascular bundles infected, but for all practical purposes it may be considered so. It is this cane which saved the sugar industry of Brazil when the gum disease first appeared in that country about 1850, and it is still the

variety principally grown there, though unfortunately usually known under the name of Lousier.

A variant with white stripes in the leaves is not infrequent. In some fields quite a proportion of the plants show this character. Three other variants also occur for which the following names were proposed by Earle for the first time: Cavengerie Negra, Cavengerie Rayada, Cavengerie Roja.

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COWGILL, H. B.—Report of the Plant Breeder. 4th Rept. Board of Comm. of Agri. of Porto Rico. 1916.

Cavengerie Negra.

(=Caña Negra, local name; probably =Cheribon of Queensland.) Frequently found with the typical form in all parts of the Island. It shows no striping but is a uniform dark reddish brown that well justifies the local name of black cane It has been brought into the Station cultures as X-19 and X-26 by Earle, but is not yet sufficiently tested to know whether it differs from the typical form in anything except color. It seems to have been the "Black Tanna" mentioned in some of the early records of the Station. The following analyses are available:

		Arrows	Extr	Brix	Sucr	Red sug	Purity	Fiber	Age
1 21 21	Cav Negra (X 19)	No	70 3	16 10	12 61	2 14	78 32	11 88	14 mo
1 21 21	Cristalina	No	70 0	17 25	15 96	0 87	92 52	9 60	14 mo
3 8 21	Cav Negra (X 19)	No	72 4	18 00	15 58	1 20	86 55	12 14	16 mo
5-4 21	Cav Negra (X 19)	No	68 4	17 20	16 28	1 09	89 45		18 mo
5-6-21	Cav Negra (X 26)	No	72 1	19 87	17 51	1 08	88 12		18 mo
5 6 21	Cristalina	No	65 1	19 55	18 93	2 41	96 82		18 mo

Cavengerie Rayada.

Found once in Yabucoa and brought into the Station cultures as X-11 by Earle. It differs from the typical form in having light-green instead of bronze stripes on the stalks.

Cavengerie Roja.

(=Rosita, =Sangre de Toro, local names.) This occurs abundantly mixed with the typical form in all parts of the Island. It is of the same dark wine color as the type, but has no striping either on stalk or sheath. No difference in cultural characters have been observed. It is quite possible that the Salangore Roja of Stahl and López Tuero belongs here.

The Chinese or So-called "Japanese" Canes

This is the group of thin, prolifically stooling canes, with closely adhering leaf sheaths and narrow, dark-colored leaves, of which Uba is the outstanding variety, although Jeswiet classifies the latter as a distinct species. These varieties of this type were listed by Mr. C. A. Barber, in his exhaustive and careful study of their morphological characteristics, as the Pansahi group of Northern India and have been erroneously termed in the literature as cane of the North Indian type, although it now appears that they are not by any means indigenous there and that we are justified by their characters and habitat in accepting Brande's & Klaphaak's classification of them as Chinese canes. They constitute a considerable proportion of the cane grown in India, China, Japan, Formosa and Natal and, since the Mosaic-Disease outbreak in Porto Rico in 1917, *Kavangire*, imported from the Argentine Republic, where it in turn had been imported from Brazil, has come to be quite widely cultivated on the west coast of the Island.

Until recently, practically all of this group were considered immune to mosaic disease after Earle's classic immunity experiments in Santa Rita, in which this type of cane proved to be the only variety which did not take the disease. Brandes & Klaphaak in 1925 mentioned, however, that the group was not homogenous with respect to susceptibility to Mosaic and reported that Tekcha, Yontan-san, Khera, Kikaigashima, Chicucha and Chikusho were slightly susceptible. Shortly afterwards the writer and Mr. W. C. Dreier found the Japanese canes, imported from Cairo, Georgia, through the courtesy of Dr. P. A. Yoder of the Bureau of Plant Industry, rather heavily infected and only recently Dr. Yoder has found that every one of these varieties occasionally takes the disease to some extent, hence our term "Mosaic-immune cane" must be dropped. All of these varieties take the disease to such a small extent and are so tolerant of it that they may be considered as practically immune and the discovery of their occasional susceptibility does not in the least affect their usefulness in districts of established Mosaic infection, but it does emphasize the danger of importing the disease into unifected sections through the bringing in of these heretofore supposedly immune types.

As a group all of these varieties are remarkably tolerant of the root disease complex, but in other countries, such as Queensland, they are subject to injury by smut and red rot (*Colletotrichum falcatum*). The pollen of this prolifically flowering group is to a large degree degenerate and it is, for this reason, impossible to secure self-

No. 1 - CAYANA No. 10 No - 2 UBA No. 3 - ZWINGA

fertilized seedlings, but, as Brandes & Klaphaak point out, hybrids are readily obtainable by using the pollen from varieties of certain other groups.

After months of careful study by the writer and Mr. Luis Serrano, we have come to the conclusion that the different varieties of this group are almost indistinguishable botanically, a conclusion concurred in by Mr. F. S. Earle, who has done considerable work with the Chinese canes. There are certain slight differences in some of the varieties which seem to be fairly constant in field study, but identification of canes sent in for that purpose is well-nigh impossible. The following descriptions will be found to vary very slightly, but they are given for what they are worth, with an expression of regret that we were not able to discover more salient and constant determining characteristics.

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BRANDES, E. W., & KLAPHAAK, P. J.—Breeding of Disease Resistant Sugar Plants for America. The Reference Book of the Sugar Industry of the World, III, 3 pp. 50–7. Pub. by the La. Planter & Sugar Mfr., July, 1925.

YODER, P. A.—Rare Cases of Mosaic Disease in Highly Resistant Varieties of Sugar Cane. U. S. Dept. Agr. Circ. 392. July, 1926.

* **Cayana.** See Plate XIX, opposite page 149; also Plate IV, opposite page 215.

In November, 1919, some cane cuttings were received by Mr. Earle under the name of Biloxi from the late S. M. Tracy of Biloxi, Miss., U. S. of A. In the letter accompanying them he said:

> "I consider this the best of the Japanese canes, of which I have several. It is much larger and stronger than the others. Syrup growers in the neighborhood to whom I have given it think it the best cane they have grown. I have lost the name, so I call it Biloxi."

Erect very vigorous, a strong stooler. It arrows, but less freely than Uba. Stalks long, slender, 1¾ to 2½ cm., green, usually with a lilac flush, considerable bloom. Internodes long, reaching as much as 15 cm., tapering, slightly larger below, furrow none. Nodes conspicuously enlarged; growth ring nearly 2 mm. wide, even or slightly sunken, greenish, root band swollen, 10 to 12 mm. wide, green or tinted; rudimentary roots large, the centers brown, in 3 rows; glaucous band about 10 mm. poorly defined, tapering sharply, the base being the narrowest part of the stalk; circlet of hairs below the bud scanty, soon deciduous. Bud ovate, plump, rather obtuse, about 10×12 to 14 mm., at first not exceeding the growth ring, margin

medium width, uniform, germination subdorsal, base glabrate, sides and apex with long appressed hairs. Leaf sheaths with scanty vestiture which is more abundant toward the margins. green, scarcely glaucous, throat sparingly lannate, no long hairs except scanty tufts at margins; collar narrow, inconspicuous, not reaching the midrib, glaucous but not lannate, ligule broad with a triangular widening at center where it reaches 5 mm., margin flambriate; ligular processes none. Leaf blades spreading, flat, narrow, 4½ cm. dark green, minutely but sharply serrulate to the base, not ciliate.

This cane is very much like Uba and Zwinga but promises to be even more vigorous and productive It may be distinguished from Uba by the uniformly swollen nodes, by the vestiture of the leaf sheaths and by the plumper buds, which germinate subdorsally, not apically as in the other two kinds. It resembles Zwinga more closely than the Uba, since both have swollen nodes and vestitures on the leaf sheaths, but they may be distinguished by the buds. In young plantings the first shoots of this cane are erect, not strongly inclined as with Uba.

The following analyses have been made:

		Arrows	Extr	Brix	Sucr	Red sug	Purity	Fiber
1 12 21	Biloxi	No	60 7	16 65	18 51	1 71	81 14	14 24
1 12 21	Cristalina	No	70 0	17 25	15 96	0 37	92 52	9 60
2 11 21	Biloxi	No	67 8	17 10	14 87	0 72	84 03	18 52
2 11 21	Biloxi	Yes	66 6	17 40	14 71	1 04	84 54	14 02
2 11 21	Rayada	No	63 6	17 15	15 35	0 81	88 92	12 87
4 11 21	Biloxi	No	66 7	17 90	16 16	0 897	90 27	12 02
4 11 21	Cristalina	No	70 1	18 10	16 92	0 265	93 48	10 47
4 27-21	Biloxi	No	65 5	20 20	17 50	0 987	86 63	11 04

These figures indicate that at full maturity it developes a satisfactory percentage of sucrose and purity. It seems to be fully equal to Uba in this respect and to promise even heavier tonnage.

It is practically immune to Mosaic. Yoder having found a slight infection in Georgia

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YODER, P. A.—Rare Cases of Mosaic Disease in Highly Resistant Varieties of Sugar Cane. U. S. Dept. Agr., Dept. Circ. 392; July, 1926. Reprinted in La. Planter and Manufacturer, LXVII, 1, pp. 6–8; July, 1926.

Japanese.

Received from Dr. P. A. Yoder, Bureau of Plant Industry, Cairo, Ga., in April, 1925. Has been planted out in comparative tonnage experiment with some ten other canes of this type, but there has not as yet been sufficient time to obtain any information as to its value in Porto Rico. Yoder states that this is the cane which has been grown for many years in the Gulf States for forage and syrup and calls it "Old Small Japanese". "It is decidedly more slender in stalk and leaves and the joints are more enlarged than any of the other varieties here discussed."

Erect, fine vigor, stools prolifically, arrows freely. Stalks long and excessively slender, green with waxy deposit, giving bluish tint. Internodes long, cylindrical, but enlarged at base, not staggered, no furrow. Nodes enlarged, parallel; growth ring medium width, even, green to concolorous; root band wide and prominent, nearly parallel; light green to concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous and prominent, brownish; leaf scar glabrate and appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internode. Buds small to medium size, 7–9 mms., scarcely exceeding growth ring, ovate to oval, germination subapical to subdorsal, margins narrow and on upper half only, lannated, no basal placs, tendency to premature sprouting. Leaf sheaths closely adherent, with scanty deciduous dorsal vestiture of coarse white hairs, light green, slightly glaucous, inner base slightly tinted with purple: throat indistinct, glabrate, few straggling hairs at margins, glaucous; collar narrow, inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center, acute apex; ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

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BRANDES, E. W., & KLAPHAAK, P. J.—Breeding of Disease Resistant Sugar Plants for America. Reference Book of Sugar Ind. of World, 1925.

YODER, P. A.—Rare Cases of Mosaic Disease in Highly Resistant Varieties. U. S. D. A. Circ. 392. July, 1926.

Japanese Fodder.

See Zwinga.

"Java Unknown".

Received in 1922 from Mr. D. W. May, Agronomist in charge of the Federal Experiment Station at Mayagüez, under this name,

although at first glance it is evidently a Chinese cane. It appears, according to Saldaña, that:

"At this (Mayagüez) Station, several years ago, we received a cane of this type, presumably from Java. In growing this, it showed certain evidences of being superior to the Uba. We entered this in our records as E. K. 28, having received some cuttings of that variety in the same mail from Java, but . . . . it is entirely different. So far we have not been able to determine where this cane came from."

Erect, fine vigor, stools prolifically, seldom arrows. Stalks long and excessively slender, green with waxy deposit giving bluish tint. Internodes long and cylindrical but enlarged at base, not staggered, no furrow. Nodes enlarged, parallel; growth ring medium length, slightly elevated, green to concolorous; root band wide and prominent, nearly parallel, concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous, concolorous; leaf scar glabrate, appressed behind; glaucous band inconspicuous, tapering from root band to girth of internode. Buds, small to medium size, 7–9 mm., premature, scarcely exceeding growth ring, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal places. Leaf sheaths closely adhering with scanty deciduous dorsal vestiture of white hairs, light green color, slightly glaucous; inner base slightly tinted with purple; throat indistinct and very scantily lannate; collar narrow, inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center; ligular process none. Leaf blades spreading with inclined tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

Saldaña goes on to say in regard to this cane:

"Being unable to identify this cane, we have called it 'Java Unknown'. The main differences from the Uba are: It has double buds, it germinates better, is more vigorous and has darker green leaves, not possessing the whitish discolorations found on other canes of this type which are sometimes mistaken for mosaic. Its main qualification, however, is the fact that it defoliates easily and this ease of stripping gives it a great advantage over the Uba cane. In a measurement of a number of stalks the Java Unknown had an average diameter of 2.10 centimeters and an average height of 8.17 feet. The Uba had an average diameter of 3.15 centimeters and an average height of 7.7 feet. In our experiments, growing the two side by side, the Java Unknown yielded a greater tonnage of cane and sugar per acre. The average weight of stools of the Java Unknown was 91.77 pounds, for the Uba 81.18. The calculated tonnage per acre was Java Unknown 55.52, Uba 49.12. These results were obtained on cane planted at a distance of 6 × 6 feet and 17 months old. Another point of superiority of the Java Unknown over the Uba is that the latter arrows freely when 10 up to 20 months old, depending on the time of the year, while the Java Unknown does not arrow.

"In a comparative analysis of these two canes, beginning January 9th and lasting through a period of eleven weeks, extraction made on a Diamond grinding mill operated by horse power, the following averages were obtained:

	Brix	Sucro	Purity	Extraction	Tons of cane per acre	Calculated tons of sugar per acre
Java unknown	18 98	14 4[illegible]	78 60	[illegible]	[illegible] 52	[illegible]
Uba	17 75	14 55	82 36	67 79	49 12	5 019

"* These calculations were based on an extraction of 76 79 for Uba and 74 61 for Java Unknown These are the approximate extractions that these canes are giving in larger mills, Java Unknown is a little over 2 per cent lower in extraction than Uba

"These results indicate that Java Unknown is a little lower in sucrose, purity and extraction but the tonnage of cane and sugar per acre are much better than Uba. But the main factor is the ease in harvesting of the Java Unknown and especially the stripping of the leaves In making these analyses it was apparent that the sucrose content and purity of these canes were greatly influenced by rains. They were both lower when the samples were cut after rains and higher following periods of dry weather This varied from 1 to 2½ per cent in sucrose content and indicated that where weather conditions can be followed in harvesting, it is best to do so."

The Mayagüez Station then goes definitely on record in recommending the "Java Unknown" to take the place of the Uba:

" . . for the following reasons Greater tonnage of cane and sugar per acre, more vigorous, darker green leaves, better stooler and non arrowing habit, but above all because of the ease of stripping leaves which has been a great drawback with the Uba cane "

Unfortunately, with the exception of the facts that it is a better germinator and does not flower at so early an age as the Uba, *although it does flower abundantly when past a year or so of age,* we have been unable in four years of experience with this variety at the Experiment Station and on the Hatillo Fruit Farm near there, at both of which places we have had "Java Unknown" planted in comparative lots with Kavangire and Cayana, to verify any others of the points of superiority enumerated for this cane in the Mayagüez Station recommedations that it replace the Uba on the west coast—in fact, on account of its excessive thinness, particularly as ratoons when it resembles Johnson Grass in thickness (Saldaña's measurements show that its average girth is 33½ per cent less than that of Uba), and because the leaf sheaths *do* adhere to the stalk as in the case of other members of this group, we have found it a much harder cane to handle than the Uba, an experience which has been borne out by Mr. W. C. Dreier and other growers on

the north coast. We frankly see no chance of this variety supplanting the Uba cane.

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*** Kavangire.** See Plate IV, opposite page 215.

Originally and unsolicitedly sent by Mr. Geo. L. Fawcett, Botanist of the Tucumán Sta., Argentine, to D. W. May, Director of the Federal Station at Mayagüez in 1915, while the writer was Director of that Station. A further importation of 10 tons of seed was made from the Argentine in 1920 by the United States Department of Agriculture as an aid in combating the outbreak of cane mosaic in Porto Rico, after Mr. Earle had definitely established its practical immunity to this disease. It is now widely disseminated and is being grown on a large scale in many parts of the Island but more particularly on the west coast.

Erect, very vigorous, stools tremendously, arrows early and very freely. Stalks very tall, slender, average about 2 cm. in diameter, green, often with lilac tint, medium heavy bloom. Internodes long, 10 or 12 to 16 or 18 cm. cylindrical or slightly larger below, furrow none. Nodes normally of same diameter as internode, occasionally the lower one enlarged; growth ring rather wide, 3 to 4 mm., even or slightly sunken, concolorous or nearly so: root band slightly oblique, 7 to 9 mm., concolorous or yellowish, usually even, occasionally swollen on the lower nodes; rudimentary roots large, crowded, yellowish, in about 3 rows; glaucous band indistinct, blending with the bloom of the internode, circlet of hairs below bud present but scanty and soon deciduous. Buds ovate, obtuse, about 10×14 mm., exceeding the growth ring by one-fourth of length. Margin narrow, uniform, about 1½ mm., germination apical, glabrate below, but with inconspicuous appressed hairs on the margins. Leaf sheaths soon glabrate, greenish, scarcely glaucous; throat sub-glabrous, the vestiture reduced to a few short hairs on the shoulders; collar narrow, reaching the midrib, glaucous; ligule with an abrupt triangular widening at center, where it reaches 4 to 5 mm., the ends 1 to 2 mm., margin irregular; ligular processes none. Leaf blades numerous, spreading, narrow, 3 to 5 cm., minutely but closely serrulate to the base.

This cane came originally from India at an early day to Brazil.

From there it was carried in 1869 to Mauritius under the name of Uba. Later is went from Brazil to Argentina, this time under the name of Kavangire, and from the Argentine it has now come to Porto Rico. Uba is today practically the only cane planted in Natal and other parts of South Africa. It is not extensively planted in Argentina on account of danger from frost, since there it is considered late in maturing although in favorable seasons it gives very heavy yields. It is a typical representative of the Chinese canes, some of which have also gone to Japan where they are extensively cultivated. The close resemblance of the Uba to these Chinese canes has led to its being also called a Japanese cane, but to the best of our knowledge it has never been grown in Japan. This class of canes are very distinct from those in general cultivation. They have such vigor and such great stooling power that they yield very heavy tonnage, notwithstanding their slender diameter. They grow well on a great variety of soils and are exceedingly resistant to root disease in all of its forms. Their preeminent characteristic is, however, their almost complete immunity to mosaic. It is this, of course, that is attracting such wide attention to these canes in Porto Rico. The reaction to gum disease has not been determined, but it is highly probable that they will prove to be resistant. These canes have been considered to be poor in sucrose and late in maturity. In Natal they are not considered to be at their best under 19 months The results obtained here so far have been unexpectedly favorable. Kavangire seems to be decidedly better than either of the other two canes of this class so far thoroughly tested (Cayana and Zwinga). As will be seen by the following analyses it has more than once given more sucrose than Cristalina from the same field This was certainly not expected and especially so early in the season. It must be noted, however, that these high analyses are all canes from hill lands where canes tend to mature early. The canes that have not arrowed, too, seem much slower in maturing. Kavangire has already taken an important place in commercial production in Porto Rico, particularly on the West Coast. In any event its introduction and testing on so large a scale constitutes one of the most interesting incidents in recent sugar-cane history, and this Island owes a debt of gratitude to the Federal Department of Agriculture for its prompt initiative in importing this seed. It is certain that the serious outbreak of mosaic disease on the west coast was easily and quickly dominated by the use of this variety. Now that this is accomplished its cultivation can be discontinued if other varieties prove more profitable such as P.O.J.–36 or D–1135.

ANALYSES, STATION CANES, RED HILL LANDS

Kind	Date	Age	Arrows	Extr	Brix	Sucr	R S	Purity	Fiber
Kavangire	12 6-20	Rat 18 mo	Yes	60 4	18 01	15 04	1 88	83 55	12 80
Cheribon (1)			No			13 69	1 67	85 88	12 29
Kavangire	1 10-21	Rat 14 mo	Yes	62 5	18 25	16 16	0 82	89 54	13 50
Cristalina	1 1 -21	Rat 14 mo	No	71 4	17 40	15 34	0 64	86 67	12 01
Kavangire	1-5 21	Pl 15 mo	Yes	64 0	19 91	16 82	0 78	89 47	13 66
Cristalina	1-5-21	Pl 15 mo	No	66 6	16 96	15 35	0 58	90 54	11.35
Kavangire	12 24-20	Pl 16 mo	Yes	60 0	16 28	13 43	0 71	82 59	15 20
Cristalina	12-24-20	Pl 15 mo	No	65 7	18 88	17 08	0 52	90 65	13 72
Kavangire	2 7 21	Pl 17 mo	Yes	61 1	17 18	15 89	0 40	88 93	14 00
Kavangire	2-7-21	Pl 17 mo	No	63 8	15 15	13 16	0 95	84 90	13 08
Cristalina	2-7-21	Pl 17 mo	Yes	65 2	18 40	17 27	0 65	93 85	11 88
Cristalina	2-7 21	Pl 17 mo	No	68 6	17 90	16 14	0 805	90 16	13 81
Kavangire	2-23 21	Pl 17 mo	No	68 5	17 60	15 93	0 399	90 02	13 86
Kavangire	2 23-21	Pl 17 mo	Yes	64 1	17 90	16 26	0 43	90 83	14 36
Kavangire	4-4 21	Pl 18 mo	No	64 5	18 40	18 58	1 06	84 86	12 67

(1) Average 5 lots canes

ANALYSES, OTHER LOCALITIES

Mayagüez Station (1)	1 1919	Pl 16 mo				12 2		81 23	
Central Guánica (2)	12 18-20	Plant		78 42	13 17	10 50	1 76	77 31	
Central Guánica D-117 (3)	12 18 20	Plant			16 72	13 24		84 22	
Hatillo Fruit Co Hill land	1 28 21	Pl 1 mo	No	66 6	14 65	13 74	0 79	83 61	13 36
Central Vannina Hill land	1 2 21	Pl 15 mo			19 25	17 19		89 09	
Hill land	2 4 21	Pl 16 mo	No	65 3	18 70	1 89	0 95	87 [illegible]0	13 88
Bayamón	2 9 21				15 65	11 69	0 99	75 97	
Mayagüez	2 10 21			62 59	16 15	13 85	0 466	85 75	
Utuado	2 19-21				17 00	12 52		72 47	
Arecibo	2-18 21	Pl 10 mo	No		14	9 32	2 52	64 27	

(1) Yield estimated at 81 56 tons per acre
(2) Tons per acre 44 75 tons sugar 3 716
(3) Tons sugar per acre 5 509

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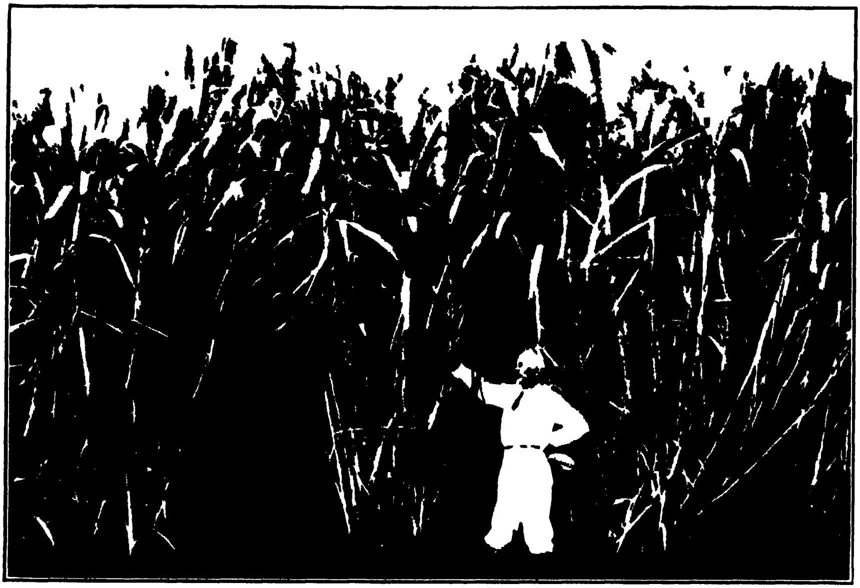
Khera

Received from Dr P A. Yoder, of the Office of Sugar Plant Investigations, U S Bureau of Plant Industry, Cairo, Ga., in April, 1925 Has been planted in comparative tonnage experiments with some ten other canes of this type, but there has as yet been insufficient time, naturally, for obtaining any definite idea as to its value in Porto Rico It was obtained originally by the Office of Foreign Seed and Plant Introduction from Aligarh, United Provinces, India, in 1912



MERTHI

C. H. 64 (21)

Erect, fine vigor, stools prolifically, arrows freely. Stalks long and excessively slender, green and purple with black waxy covering, some flush. Internodes long, cylindrical but enlarged at base, slightly staggered, no furrow or only slight trace. Nodes enlarged, parallel; growth ring medium width, even, green to concolorous; root band wide and prominent, nearly parallel, white to concolorous; rudimentary roots large, few and scattered, 2–3 in rows, prominent, brownish; leaf scar glabrate, appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internode. Buds, small to medium size, 7–9 mms., exceeding growth ring by one-third to one-half, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal placs, tendency to premature sprouting. Leaf sheaths closely adherent with scanty, deciduous, dorsal vestiture of short, white hairs, light green, slightly glaucous; inner base slightly tinted with purple; throat inconspicuous, glabrate, with few straggling hairs at margins, glaucous; collar narrow, inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center, acute apex; ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

REFERENCES

See under Japanese.

Merthi. See Plate XX, opposite page 157.

This is identical with Uba, *q. v.* The planting of this variety which we have at the Insular Station is a type selected for the past eight years by Mr. J. R. Zell, of Finca "El Conde", Cent. Hershey, Cuba, who calls it "Merthi—Zell's Strain', and sent it to Commissioner Carlos E. Chardón in September, 1925. Mr. F. S. Earle, of the Tropical Plant Research Foundation staff in Cuba, wrote the author on 11th June, 1926, in regard to this cane as follows:

"I had no true Merthi in this field, but at another place it has run much lower than Uba all season. I don't know why, for I confess that I cannot tell them apart. Whether or not Zell has permanently improved his strain by eight years of selection I do not know. I incline to think that he has. A number of plantations are going in for it on a large scale.

In sending the author the subjoined series of analyses, Mr. Zell wrote under date of 28th November, 1925:

"I cannot have an opinion as to the ultimate value of this strain for Porto Rico because conditions, not only of soil and climate, but, also, of mode of working are so radically different from what is the case here in Cuba; however,

it may have a place for which it may be particularly adapted—some type of soil of some exceedingly dry section where soil is thin and poor, etc., etc., that your study of the variety will bring out. May I observe that in considering the analyses which I have sent it should be borne in mind that this year has been one exceptionally dry for Cuba. This has brought about a condition which, in my opinion, favors this cane greatly by checking its eternal propensity and ABILITY to keep on growing when this is at all possible. Of course, when it once reaches maturity it will stop growing—but that won't be until it is 22 months old or older, from what I have noticed, hence it will be very important that it be allowed to go to fullest maturity for best results. The records of analyses which I sent were made in a year in which the crop as a whole is 25 to 40 per cent short due to lack of rain. . . The lack of rain noted has favored the cane referred to, so this should be borne in mind in judging its qualities. . . . . My experience has been that the deeper it is planted, the better, as, otherwise, it puts out too many suckers and the canes are liable to be much thinner than if planted deep. Also, every time I plant I discard all canes with swollen or too prominent eyes or buds, aerial roots, short internodes and thin canes. When I first got this cane several years ago it was a sorry looking thing, but the percentage of respectable canes has increased wonderfully while the other class has been on the decrease and this to such an extent that now I have many stools which are nearly all good canes."

CANES CUT AT "EL CONDE" IN HABANA PROVINCE AND SENT TO CENTRAL "CARACAS" TO E. KOWALT, FOR ANALYSES

(×) Arrowed November 1924.
(=) Not arrowed
All Merthi planted November 1923.

Date cut and sent	Date analyzed	Variety	Hand-mill work			Calculated to actual mill work			
			Brix.	Sucr.	Purity	Brix	Sucr.	Purity	Sac. cane
1925	1925								
10-22	10-25	Merthi Z. strain (×)	16.65	14.58	87.60	16 15	12 86	79 60	10.80
10-22	10-25	Merthi Z. strain (=)	18 75	17.30	92.30	18 19	15.33	84.30	12 83
10.22	10-25	CH-64 (21)	15 80	12.96	82 00	15.33	11.34	74 00	9.53
10-22	10-25	C 553	16 50	14.27	86.50	16.00	12 56	78 50	10.55
10-22	10.25	C-85	16.25	13.88	85.40	15 75	12 19	77.40	10 24
10-22	10-25	Crystalina	15 20	12.74	83.80	14 70	11 14	75 80	9.36
10-29	11-1	Merthi Z. strain (×)	17.9	16.03	89 5	17.4	14 18	81.5	11.91
10-29	11-1	Merthi Z. strain (=)	17.6	14.24	80 9	17 0	12 39	72 9	10.40
10-29	11-1	CH-64 (21)	18.9	17.01	90 0	18 3	15 0	82.0	12.60
10-29	11-1	C 553	17.9	14.12	78 8	17.4	12 32	70.8	10.35
10-29	11-1	Crystalina	19 9	18 35	92 20	19 3	16 42	84 2	13.79
11-5	11-8	Merthi Z. strain (×)	16 0	13 06	81 6	16.0	11.78	73.6	9.90
11-5	11-8	Merthi Z. strain (=)	20.7	18 98	91 7	20.7	17 32	83.7	14.55
11-5	11-8	CH-64 (21)	15 2	11 39	75 0	15 2	10.18	67 0	8.55
11-5	11-8	C 553	19 2	16 53	85.6	19 2	14.90	77 6	12.52
11-5	11-8	Crystalina	18 4	16 72	90 9	18 4	15.25	82.9	12.81
11-12	11-15	Merthi Z. strain (×)	19 9	18.25	91.7	19 3	16.15	83.7	13.57
11-12	11-15	Merthi Z. strain (=)	19 4	17 65	91.	18.8	15 60	83.	13.10
11-12	11-15	CH-64 (21)	16 9	13 44	79 50	16.4	11 73	71.5	9.85
11-12	11-15	C 553	17.	13.83	81.4	16.5	12 11	73.4	10 17
11-12	11-15	Crystalina ratoon	19.9	18 4	92 5	19 3	16 31	84 5	13.07
11-19	11-22	Merthi Z strain (×)	17.	15 02	88.30	16.5	13.25	80.30	11.13
11-19	11-22	Merthi Z. strain (=)	18.9	17.15	90.80	18 3	15 55	82.80	12.72
11-19	11 22	CH-64 (21)	12 9	14.79	82.60	17.4	12 93	74 6	10 90
11-19	11-22	C 553	18 7	15 48	82.50	18 10	13.48	74.5	11.32
11-19	11-22	Crystalina ratoon	17 30	15.26	88.20	16 8	13.47	80.2	11.31

"Merthi" from canes planted November 1923.
Crystalina is from second ratoons about 20 months old in October 1925.
Other varieties are from plant cane 21 to 22 months old in October 1925.

The following letter was sent to Mr. Zell from Central Jatibonico:

A. V. Switzer,
Central Jatibonico.
Prv. Camagüey, Cuba.

November 2, 1925.

Mr. J. R. Zell,
"El Conde",
Prv. Havana.

Dear Sir:

I regret that I have not answered your letter of September earlier, but time passed so fast and work here kept me on the go.

In regard to the "Merthi", I will say it is the best standing variety out of 23 which I have planted here in the experimental plot. Many of the stools are now having 40 to 45 shoots. Very few of the stools go below 25 shoots.

No signs of the mosaic disease have been noticed in the "Merthi", but in nearly all the others I have the disease.

As you mentioned in your letter, this cane is at its best when 18 to 20 months old. I am awaiting the time to see it then.

If you ever should make a trip over this way, I would be glad if you will stop off at Jatibonico and visit our plot here.

I am, sir, very respectfully yours.

(Signed) A. V. Switzer.

Oshima.

Received from Dr. P. A. Yoder, Office of Sugar Plant Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, Cairo, Georgia, in April, 1925. It was imported by the Section of Seed and Plant Introduction from Kagoshima Ken, Japan, through the Yokohama Nursery Co., in December, 1910. Has been planted out in comparative tonnage experiment with some ten other canes of this type, but there has not as yet been sufficient time to obtain any data as to its possible value in Porto Rico.

Erect, fine vigor, stools prolifically, arrows freely. Stalks long and excessively slender, green with waxy covering giving bluish tint, becoming yellow with age, some flush. Internodes long, cylindrical, but enlarged at base, not staggered, no furrow, or only slight trace. Nodes enlarged, parallel; growth ring medium width, even, green to concolorous; root band wide and prominent, nearly parallel, concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous and concolorous; leaf scar glabrate, appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internode. Buds, small to medium size, 7 × 9 mms., scarcely exceeding growth ring, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal placs. Leaf sheaths closely adherent, with scanty deciduous dorsal vestiture of short,

white hairs, light green, slightly glaucous, inner base slightly tinted with purple; throat inconspicuous, glabrate, with few straggling hairs at margins, glaucous; collar narrow, inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center, ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

REFERENCES

See under Japanese.

SPI–33243.

S. P. I. denotes the Office of Foreign Seed and Seed Introduction of the U. S. Bureau of Plant Industry. This cane was obtained from Dr. E. W. Brandes, in charge of the Office of Sugar Plant Investigations, in May, 1924. It has been planted out in comparative tonnage experiments with some ten other representatives of this type, but there has been no time as yet to obtain definite data as to its possible utility on this Island.

Erect, fine vigor, stools and suckers prolifically. Stalks long and excessively slender, yellow to dark green, heavily coated with black bloom, no flush. Internodes long, cylindrical, slightly enlarged at base, not staggered, furrow slight to none. Nodes enlarged, parallel; growth ring medium width, even, green to concolorous; root band wide and prominent, nearly parallel, concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous and concolorous, leaf scar glabrate, appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internodes. Buds small to medium size, 7–9 mms., prematurely sprouting, scarcely exceeding growth ring, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal placs. Leaf sheaths closely adherent, lanuate dorsally, light green, slightly glaucous, inner base slightly tinted with purple; throat narrow and indistinct, scantly lannated; collar narrow and inconspicuous, reaching midrib, glaucous; ligule narrow and abruptly enlarged at center; ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

Tekcha.

Received from Dr. Yoder, Cairo, Georgia, in April, 1925. It was imported by the S. P. I. of the U. S. Bureau of Plant Industry from Japan, through the Yokohama Nursery Co. It has been planted out at the Station in comparative tonnage experiments with some ten

other representatives of the Chinese group, but there has as yet been insufficient time in which to form an idea of its value for Porto Rican conditions. Mr. F. S. Earle, Cane Technologist of the Tropical Plant Research Foundation, wrote the author from Cuba, under date of 11th June, 1926, in regard to this variety:

> "Tekcha, here in my sandy *sabana* land, is leading the whole bunch in tonnage and is ratooning marvelously, even being ahead of Kassoer. It is not too good in sucrose, but is better than Kassoer."

Erect, fine vigor, stools prolifically, arrows freely, takes mosaic. Stalks long and excessively slender, green with waxy deposit, giving bluish tint and becoming yellow with age. Internodes long, cylindrical but enlarged at base, not staggered, no furrow. Nodes enlarged parallel: growth ring medium width, even green to concolorous; root band wide and prominent, nearly parallel, concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous and concolorous; leaf scar glabrate, appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internodes. Buds, small to medium size, 7–9 mms., scarcely exceeding growth ring, ovate to oval, germination subapical to subdorsal, margins narrow and on upper half only, lannate, no basal placs. Leaf sheaths closely appressed with scanty deciduous, dorsal vestiture of short, white hairs, light green, slightly glaucous, inner base slightly tinted with purple; throat indistinct, glabrate, with few straggling marginal hairs, glaucous; collar narrow and inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly large at center; ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green margins minutely serrulated almost to base, sparse basal ciliation.

REFERENCES

See under Japanese.

Uba. See Plate XIX, opposite page 149.

This is the prototype of the Chinese canes and is the one which has attained such wide fame in Natal. It was obtained from Dr. P. A. Yoder, of the Bureau of Plant Industry at Cairo, Georgia, in April, 1925, for a comparative study of the *Kavangire* which is so widely planted on the west coast of Porto Rico. It was imported by the S. P. I. from Natal, through Pretoria, Transvaal, South Africa, in September, 1925. It has been planted at the Station in comparative tonnage experiments with Kavangire and a number of other representatives of the Chinese group, but there has as yet been insufficient time to form an idea as to its merits here.

Erect, fine vigor, stools prolifically, arrows abundantly. Stalks long and excessively slender, green with waxy deposit giving bluish tint, becomes yellow with age. Internodes long, cylindrical but enlarged at base, not staggered, no furrow. Nodes enlarged, parallel; growth ring medium width, slightly elevated, green to concolorous; root band wide and prominent, nearly parallel, concolorous; rudimentary roots large, few and scattered, 2–3 in rows, inconspicuous and concolorous; leaf scar with occasional ciliation, appressed behind; glaucous band inconspicuous, tapering from root band to girth of internodes. Buds small to medium size, 7–9 mms., slightly exceeding growth ring, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal placs. Leaf sheaths closely adhering, with scanty deciduous, dorsal vestiture of white hairs, light green, slightly glaucous, inner base lightly tinted with purple; throat indistinct and very sparsely lannate; collar narrow; inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center, ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

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Yon-Tan-San (Yontanzan).

Obtained from Dr. Yoder, Cairo, Georgia, in April, 1925. It was imported by the S. P. I. X. from Okinawa Ken, Kiushu, Japan, through the Yokohama Nursery Co., in June, 1910. It has been planted out in tonnage experiments with the other representatives of the Chinese group which we have at the Station, but there has as yet been insufficient time in which to form any idea of its value.

This variety was imported directly from Japan by the Tucumán Agricultural Experiment Station in Argentina in the year 1917. It was described by the Japanese authorities as an improved type from the Island of Lioo-Choo. Cross reported it in Tucumán as having a slightly larger stalk and less fiber than the other canes of this type and to also be easier to strip, but we have not been able to verify these characteristics.

Erect, fine vigor, stools prolifically, arrows abundantly. Stalks long and excessively slender, green with waxy deposit giving bluish tint. Internodes long, cylindrical, but enlarged at base, not stag-

gered, no furrow. Nodes enlarged, parallel; growth ring medium width, even, green to concolorous; root band wide and prominent, nearly parallel, green to concolorous; rudimentary roots large, few and scattered, 2–3 in rows, conspicuous, brownish; leaf scar with occasional ciliation, appressed behind; glaucous band inconspicuous, tapering from prominent root band to girth of internode. Buds small to medium size, 7–9 mms., slightly exceeding growth ring, ovate, germination subapical, margins narrow and on upper half only, lannate, no basal placs. Leaf sheaths closely adherent, with scanty deciduous dorsal vestiture of white hairs, light green, slightly glaucous, inner base lightly tinted with purple; throat indistinct and very sparsely lannated; collar narrow, inconspicuous, reaching midrib, glaucous; ligule narrow at sides and abruptly enlarged at center, ligular process none. Leaf blades spreading with declining tips, narrow, 4–6 cms., dark green, margins minutely serrulated almost to base, sparse basal ciliation.

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ROSENFELD, A. H.—Report of the Special Technologist for Cane. Annual Report of the Ins. Expt. Sta. of Pto. Rico. 1924–25.

* **Zwinga.** See Plate XIX, opposite page 149.

(= Japanese Fodder.) Introduced from Luisiana by the Federal Station at Mayagüez. Date of introduction not known. It is now also in the plots at the Insular Station but has not been seen elsewhere in the Island. In the fall of 1919 the Federal Station brought some seed cane from St. Croix under the name of Kavangire. It was observed by the present writer to be distinct from the Kavangire brought from the Argentine and was thought to be Zwinga. This now seems doubtful. This St. Croix cane seems to more nearly resemble what is here called Cayanna than it does either Uba or Zwinga. Whatever its identity, small lots of it were somewhat widely distributed. It seems to be slower in ripening and poorer in sugar than the Uba.

Erect, very vigorous, heavy stooler, arrows infrequently. Stalks long, very slender, about 2 cm., green or ash-colored from the light bloom. Internodes long, 13 to 15 cm., straight, nearly cylindrical but usually larger below, furrow slight or none; nodes abruptly and conspicuously swollen; growth ring slightly sunken, 2 to 3 mm., broad, yellowish-green, conspicuous; root band abruptly swollen 10 to 12 mm. wide, concolorous; rudimentary roots large, crowded,

becoming prominent, concolorous, in 3 to 4 rows; leaf scar glabrous, closely appressed behind; glaucous band tapering rapidly, its lowest part being the narrowest part of the stalk. The circle of hairs below the bud is strongly developed. Buds ovate, about 10 × 12 mm., exceeding the growth ring by one-fourth of length, margin uniform, medium narrow, germination apical, basal places of hairs poorly developed, abundant, long, appressed marginal hairs. Leaf sheaths with a distinct but short and somewhat deciduous vestiture which is usually more abundant on the sides than on the back, green, little or no bloom; throat minutely lannate but with no long hairs or sometimes scant marginal tufts; collar pale, indistinct, glaucous; ligule wide and with an abrupt triangular widening at the center where it reaches 5 to 6 mm., the edge fimbriate; ligular processes none. Leaf blades numerous, spreading, narrow, 4½ to 5 cm. bright green, very minutely serrulate.

This cane very closely resembles the Uba but may be distinguished by the more abundant vestiture on the leaf sheaths and the abruptly swollen nodes. In the Uba nodes and internodes are normally of the same diameter. The buds are flat and germinate apically as in Uba. This serves to distinguish it from Cayana which has plumper buds that germinate subapically or nearly subdorsally

Like the Uba it is almost completely immune to mosaic and is exceedingly resistant to all forms of root disease Its reaction to gum disease is not known, but it is probably immune.

This cane is extensively grown in the Southern States as a forage for cattle and it is considerably used there for syrup making. It probably has but little value for sugar making on account of its late maturity and low sucrose content A few analyses are given

Kind	Date	Brix	Red Sug	Purity	Fiber
Zwinga	12 30 20 Pla 1° mo		1 96	77 8[illegible]	9 85
Y Cal	12 30 20		2 00	78 51	13 48

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Blouin, R. E.—Una Comparación de los Resultados de los Ensayos con las Cañas de Java con los de las Cañas "Kavangire", "Zwinga" y Morada y Rayada del País. Revista Industrial y Agrícola de Tucumán (Argentina), IV, 4, pp. 141–50; Sept., 1913.

Stubbs, W. C.—Sugar Cane, Field Experiments, Varieties. La. Agr. Ex. Station, Bull. 2, N. S.; Feb., 1924.

The Coimbatore Seedlings

These are the famous canes bred at the Coimbatore Experiment Station in India by Mr. C. A. Barber many years ago, those which are enumerated below having proven in recent years in India to be very resistant to drought, mosaic and root disease, characters inherited from their P.O.J. parents, and beginning to obtain wide distribution in the drier parts of India.

Co-210. See Plate 11, opposite page 119.

Seedling of P.O.J. 213, male parent being Madras 2 or 1017. Sent to the Station in February, 1925, by Rao Sahib T. S. Venkatramen, Government Sugar Cane Expert of the Agricultural College of Coimbatore, South India. An extremely thin, sprawling cane very much resembling the Tucumán seedlings in small girth and enormous stooling characteristic. Mr. F. S. Earle wrote us from Herradura, Havana Province, Cuba, under date of 18th, August, 1925;

> "Here Co-210, 213 and 214 are all fairly promising, with 213 decidedly best."

Mr. Wynne Sayer, Secretary of the Pusa Sugar Bureau in India, reports in the International Sugar Journal that—

> "Co-210 is a good ratooner, Co-214 coming next to it, while Co-213 stands last when there is little rain."

Erect, good vigor and fine stooler. Stalks long and exceedingly slender, violet, overlain with heavy wax deposit, tendency to split. Internodes long, cylindrical, but slightly enlarged at base, not staggered, furrow trace to none. Nodes enlarged, parallel; growth ring wide, prominent, yellowish green; root band wide, parallel, white; rudimentary roots small, few and scattered, 2–3 in rows, inconspicuous, light purplish; leaf scar glabrate, appressed behind; glaucous band tapering, broad and inconspicuous. Buds large, 8–10 mms., ovate, exceeding growth ring by one-third, germination apical, margins broad and flat, abruptly shouldered above, apices purple, glabrate, no apical tufts, very light basal placs. Leaf sheaths closely adherent, glabrate, no wax, tinted, inner base heavily splotched with purple; throat narrow, lannated, with short appressed hairs, long straggling hairs at margins; collar narrow, reaching midrib, glaucous; ligule medium width, 2–3 mms., at sides and becoming abruptly enlarged at center, fiambrate, no ligular process. Leaf blades spreading with declining tips, narrow, 4–5 cms., dark

green with white midrib, margins minutely and uniformly serrulated, long ciliae at base.

No data yet available on behavior of this variety in Porto Rico, although in tonnage experiment planted out in fall of 1925, it shows a remarkable stooling quality.

REFERENCES

SAKER, WYNNE.—Mill Trials of Coimbatore Sugar Cane Seedlings 232 and 233. Agricultural Journal of India, XIX, Pt. IV. 1924.

Idem.—The Pusa Sugar Bureau Scientific Reports of the Agr. Res. Inst. of Pusa, 1923–4. Abridged in International Sugar Journal, XXVII, pp. 438–42. Aug., 1925.

Co–213.

Seedling of P.O.J. 213, male parent being Madras 2 or Kansar. Sent to the Station in February, 1925, by Rao Sahib T. S. Venkatramen, Government Sugar Cane Expert of the Agricultural College of Coimbatore, South India. An extremely thin, sprawling cane, very much resembling the Tucumán seedlings in small girth and enormous stooling characteristic. Mr. F. S. Earle wrote us from Herradura, Havana Province, Cuba, under date of 18th August, 1925:

"Here Co–210, 213 and 214 are all fairly promising, with 213 decidedly best."

Erect, good vigor, fine stooler, yellow base color with abundant bluish wax deposit becoming flushed to violet and red on exposure to sun. Internodes long and enlarged at back, very slightly staggered, no furrow. Nodes nearly even, oblique; growth ring even, narrow and inconspicuous, concolorous: root band narrow, oblique, concolorous; rudimentary roots small, very few and scattered, 2–3 in rows, purplish, leaf scar glabrate and appressed behind; glaucous band slightly constricted, broad and conspicuous. Buds medium size, 7–9 mms., not exceeding growth ring, orbicular, germination dorsal, margins medium width, flat, uniform, glabrate, no apical tufts nor basal placs. Leaf sheaths glabrate, no wax, tinted, inner base heavily splotched with purple; throat narrow, lannate, with short appressed hairs and long straggling hairs at margins; collar narrow, reaching midrib, glaucous; ligule medium width, 2–3 mms., at sides, becoming abruptly enlarged at center, fiambrate, no ligular process. Leaf blades spreading with declining tips, narrow, 4–5 cms., dark green, white midrib, minutely and uniformly serrulated, some basal ciliation.

Mr. Wynne Sayer, Secretary of the Pusa Sugar Bureau in India, reports in the *International Sugar Journal* that—

"Co–210 is a good ratooner, Co–214 coming next to it, while Co–213 stands last when there is little rain."

No data yet available on behavior of this variety in Porto Rico, although in tonnage experiment planted out in fall of 1925, it shows a remarkable stooling quality.

REFERENCES

SAYER, WYNNE.—Mill Trials of Coimbatore Sugar Cane Seedlings 232 and 233. Agricultural Journal of India, XIX, Pt. IV. 1924.

Idem.—The Pusa Sugar Bureau. Scientific Reports of the Agr. Res. Ins. of Pusa, 1923–4. Abridged in International Sugar Journal, XXVII, pp. 438–42. Aug., 1925.

Co–214.

Seedling of Striped Mauritius. Male parent probably a cross of Saretha with *S. spontaneum*. Sent to Station from Coimbatore by Government Sugar Expert Venkatramen in February, 1925. An extremely thin, sprawling cane—even more so than Co–210 and 213—closely resembling the Tucumán seedlings in type of growth and excessive thinness. Mr. Wynne Sayer wrote us from Pusa that it comes next to Co–210 as a good ratooner, while Mr. F. S. Earle, in a letter from Herradura, Province of Havana, Cuba, dated 18th August, 1925, reports it as "fairly promising".

Recumbent, vigorous, good stooler, arrows early. Stalks long and excessively slender, dirty yellowish green, changing to purple on exposure to sun. Internodes medium length, cylindrical, slightly staggered, no furrow. Nodes swollen, parallel; growth ring medium width, very slightly elevated, light green to brown; root band wide, parallel, white; rudimentary roots small, few and scattered, prominent, yellowish; leaf scar glabrate, appressed behind; glaucous band narrow, very slightly constricted, inconspicuous. Buds small, 5–7 mms., not exceeding growth ring, orbicular, germination subdorsal, margins narrow, flat, on upper half only, abruptly enlarged at sides and concave at apex, no apical tufts nor basal placs. Leaf sheaths glabrate, no wax, violet, inner base slightly tinted; throat narrow, indistinct, lannate, long tufts at margins; collar narrow, reaching midrib, glaucous; ligule narrow, 2–3 mms., becoming very much enlarged, 8–12 mms., at center and convex above and below; no ligular process. Leaf blades spreading with declining tips, narrow, 4–5 cms., dark green, white midrib, serrated to base, long basal ciliae.

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SAYER, WYNNE.—Mill Trials of Selected Coimbatore Seedlings. Agr. Jour. of India, XVIII, Part. III.

Co-281.

This variety belongs to a later series of seedlings than the preceding one, Sayer, in his report on the Sugar Bureau of Pusa for 1923–24, giving the parentage of the Coimbatore seedlings only through Co–280, hence the ancestry of this variety is unknown to the writer, although its appearance strongly suggests P.O.J. blood. It was sent to us from Cuba by Mr. F. S. Earle, Cane Technologist of the Tropical Plant Research Foundation, who is most enthusiastic over its development in that country, in September, 1925. On 11th June, 1926, Mr. Earle wrote us as follows in regard to this cane:

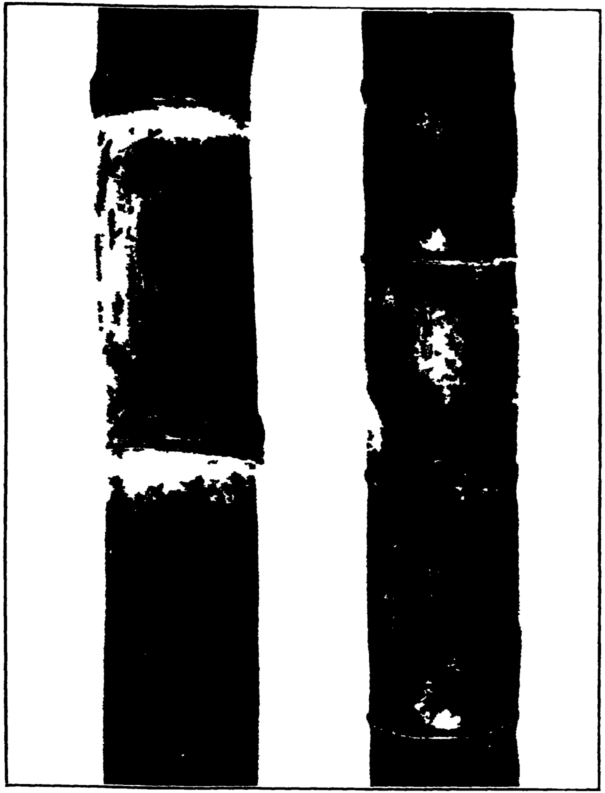
> "The only real discovery I have made this winter is the Co–281. It is making big tonnage, fully as much as Uba on most soils and is very early in maturing. At my first analyses in December it took first place out of over a hundred kinds with over 17 per cent sucrose and kept either first or second place until March." *

Erect, good vigor, splendid stooler. Stalks long, thin, wine colored, heavy bloom. Internodes long, cylindrical, very slightly staggered, no furrow. Nodes almost even, parallel; growth ring wide, 4–6 mms., slightly elevated, green changing to concolorous; root band wide, parallel, yellowish green to concolorous; rudimentary roots large, few and scattered, indistinct, 2–3 in rows, purplish to concolorous; leaf scar glabrate and appressed behind; glaucous band wide, distinct, slightly constricted. Buds medium size, 7–9 mms., broadly ovate, reaching growth ring, germination apical, margins very narrow, even, glabrate, on upper half only, no apical tufts nor basal placs. Leaf sheaths glabrate, glaucous, slightly tinted at outer base only; throat narrow split at sides, covered with black wax, short, scattered hairs at sides; collar narrow, reaching midrib, glaucous; ligule narrow at sides becoming abruptly convex at center, no ligular process. Leaf blades erect, with slightly declining tips, narrow, 5 cms., dark green, minutely and uniformly serrulated, no basal ciliation.

Crema.

A local name that seems to be rather loosely applied. The canes

* Earle has further ratified this statement in his "Sugar-Cane Varieties" written for the Tropical Plant Research Foundation (1927) and says: "This is a remarkable cane and promises to be one of our most valuable ones . . . . It is, however most remarkable for its high sugar content, etc.—C. E. CHARDÓN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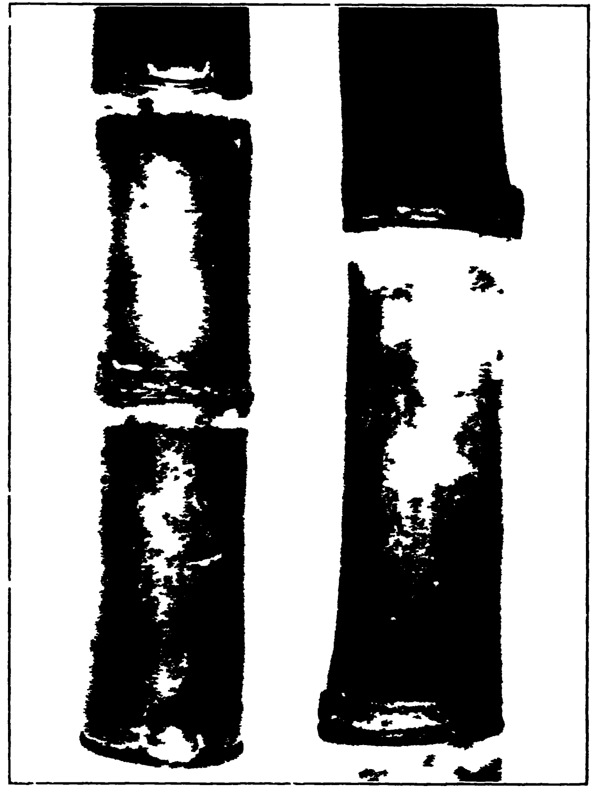

so far brought in under this name have proved to be either B-208 or Penang, although the writer saw a beautiful field at Aguirre under this name, which was neither of the above varieties. Mr. Brebner, however, told him that the cane had the disadvantage of becoming pithy very shortly after maturity.

*** Creole (Criolla).**

The first, and for two hundred and fifty years the only cane planted in Porto Rico. Completely superseded as a commercial cane in the early days of the nineteenth century by Otaheite and since that time only planted for chewing. Now almost extinct, very rarely seen.

Erect, of rather feeble growth, arrows occasionally. Stalks slender, rather short, green with slight flush when fully exposed, scanty bloom. Internodes medium short, straight or slightly staggered cylindrical, furrow shallow but well marked for entire length of internode. Node slightly constricted, somewhat oblique; growth ring narrow, inconspicuous, concolorous; root band narrow, oblique, 5 to 8 mm., rudimentary roots inconspicuous, in about 3 rows; leaf scar glabrous or with a few short scattered cilia, narrow; glaucous band slightly constricted, 8 to 10 mm., conspicuously whitened when young, circlet of hairs below bud none. Bud narrowly ovate-triangular, about 8 to 10 mm., exceeding the growth ring, margin narrow, slightly wider below but not shouldered, germination apical, glabrate or nearly so. Leaf sheath glabrous, green faintly glaucous; throat lannate, dark, with medium long hairs towards margins; collar narrow, reaching the midrib, glaucous, sparingly lannate at the margins; ligule widest at center, reaching 4 mm., the ends tapering, nearly even; ligular processes none. Leaf blades erect, the tips declined, somewhat plicate, narrow, 3 to 4½ cm., light green, serrulate with long teeth, the base somewhat ciliate.

Of historical value only and we are so preserving it in the Station collections.

*** Cristalina.** See Plate XXI, opposite page 169.

(=Light Cheribon, =White Transparent.) Probably introduced as an admixture with Otaheite in the early part of the nineteenth century. Now widely planted on the south coast (it was until Mr. Earle's time the only variety planted at Central Aguirre) and occurring frequently in mixed planting in all parts of the Island until the advent of BH-10(12) and SC-12/4. It was probably second in total acreage in Porto Rico, being surpassed only by the Rayada, which is now disappearing. It is practically the only cane planted in Cuba and it occurs abundantly in many other parts

of the world. It is safe to say that no other variety produces as large a part of the world's sugar supply as the Cristalina.

Erect, then declined, vigorous, a good stooler, arrows freely at some times and on some soils, under other conditions it seldom arrows. Stalks medium diameter, green usually with a strong pink flush, bloom heavy. Internodes medium length, cylindrical or somewhat tumid, straight or slightly staggered, furrow evident of medium depth. Nodes oblique, constricted; growth ring yellowish green, conspicuous, elevated, root band narrow, oblique, slightly constricted; rudimentary roots small, inconspicuous, pallid with brownish center, in about 3 rows; leaf scar glabrous, wide in front, appressed behind; glaucous band constricted, rather narrow, not very conspicuous, blending with the bloom of the internode. Buds medium size, triangular-ovate with rounded base, exceeding the growth ring, margin wide, strongly shouldered below; germination apical, base and apex appressed, ciliate. Leaf sheaths glabrous, greenish, quite glaucous, throat densely lannate and with abundant long coarse hairs; collar conspicuous, reaching the midrib, lannate throughout; ligule medium width, margin even; ligular processes usually only one developed. Leaves abundant spreading, flat, medium length and width, about 7 cm., bright green, minutely serrulate, the margins at the base ciliate for two or three inches.

As indicated by long experience, not only in Porto Rico but in all parts of the world, this is one of the best varieties for general planting and one of the very few on which it is safe to base the entire sugar industry of any region. Its continued planting is strongly urged on all those lands where it still continues to give a satisfactory tonnage. It is adapted to a wide range of soil conditions. In maturity it is a mid-season cane, not being at its best under 15 months except late in the season under conditions of drouth when even 11 or 12 months' cane developes a high percentage of sucrose. Even when immature at the beginning of the grinding season it shows a fair percentage of sucrose and purity. Other varieties frequently surpass it in these respects in special instances, but no other variety in general cultivation except B.H. 10(12) surpasses it in average richness at all ages and under all conditions. It usually keeps well in the field after maturity and late plantings or late-cut ratoons may be safely held over for a long crop or *caña quedada*. Unfortunately, this grand kind is beginning to fail on some of the more exhausted and compacted lands. In such situations it is now necessary to either change the prevailing cultural methods or to look for hardier, more resistant varieties. It can be classed as

only medium in its resistance to root disease, vascular bundle fungus, mosaic, and gum disease, being attacked by all of these troubles but suffering less damage from them than some other kinds.

The following selected analyses will show about what may be expected from it at different ages and conditions. Other analyses of Cristalina will be found under most of the other older varieties where they are given as a basis for comparison:

Date	Age	Extr	Brix	Sucr	Red Sug	Purity	Fiber	
12-8-20	10 mo Rat.	74 1	15 88	12 85	2 29	80 56	8 28	Evidently green 2nd in sucrose out of 37 kinds
1-5-20	14 mo Rat	66 4	19 68	18 10		91 90		
1-5-21	15 mo Pla.	66 6	16 96	15 85	0 56	90 86	11 85	
2-4-21	16 mo Pla	65 2	18 40	17 27	0 65	88 85	11 83	
11-29-20	20 mo Pla	61 5	16 47	14 52	1 20	88 16	12 32	Caña quedada
4-1918	11 mo Pla	. .	22 30	20 0		93 90		Dry weather
6-1918	13 mo. Pla.	.	18 68	16 5		88 32		Effect of rain

In tonnage Cristalina is often surpassed by such low sucrose canes as Yellow Caledonia, B–3412 and Cavengerie. No variety, however, responds more rapidly to better cultivation and the heavier application of fertilizers. This is shown by the remarkable yield of an average of 81 tons per acre on a 40-acre field made at Aguirre, crop of 1918. Cristalina is a strong ratooner. It is giving good ratoon crops on the south coast, where up to ten years ago ratooning had been practically abandoned. It is chiefly to the strong ratooning power of Cristalina that Cuba owes her cheap cane supply. As seen from the above analyses, it may be planted either in fall or spring and on any type of soil that would be considered good cane land.

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Gossett, B. S.—Notes on the Sugar-Cane Experiments in British Guiana. Bull of the Dept. Agr of Jamaica, New Series, II, 7. pp. 207-18; 1913.

The Cuban Seedlings

These seedlings were bred at the Experiment Station at Santiago de las Vegas, mostly by Mr. T. H. Lougher, formerly Plant Breeder at the Porto Rican Insular Station They date from about 1913. The ones discussed below are the only ones which have given any particular promise in Cuba.

C–35 (Super-Cristalina).

Seedling of D–74, bred by Mr. T. H. Lougher in the Agricultural

Experiment Station at Santiago de las Vegas, Cuba, in 1914. Sent to Insular Experiment Station of Porto Rico, in July, 1924, by Mr. R. Menéndez Ramos. A fine-looking cane, but, as tonnage experiments have been started only recently with it at the Insular Station, there are no data available as to its probable value here. Drs. Calvino report a yield of 250 tons of cane per hectare from this variety in Cuba, but, inasmuch as this yield was calculated from the harvesting of one single stool, these figures can hardly be taken as indicative of the value of this cane in the "Pearl of the Antilles".

Erect, good vigor, fair stooler. Stalks long, medium to good girth, greenish yellow to yellow, some wax, no bloom. Internodes medium to long, staggered, cylindrical or sligthly enlarged on sides opposite bud, slightly appressed at sides laterally to bud; no furrow. Nodes prominent and parallel; growth ring wide, yellowish green; root band rather narrow, rudimentary roots in 2 to 3 rows; leaf scar, glabrate, appressed behind and prominent in front; glaucous band broad, almost even, inconspicuous. Buds small, reaching or sometimes exceeding growth ring; two shapes: one, round, swollen with obtuse or oval apex and the other triangular and pointed; all buds have a distinct margin and minute silvery hairs on apex, sides and base; germination apical. Leaf sheaths with heavy wax covering, subglabrate, tinted with purple within and without; throat and collar narrow and lannated; ligule round at apex, wide at center, 2 or 3 times more than at sides; ligular process none. Leaf blades broad.

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CALVINO, EVA MAMELI Y MARIO.—La "Caña C 35" o sea la "Super-Cristalina". Chaparra Agrícola, I, 9, pp. 1–11. Enero, 1925.

ROSENFELD, ARTHUR H.—Informe del Tecnólogo Especial para Cañas. Informe del Comisionado de Agricultura y Trabajo al Honorable Gobernador de Puerto Rico, 1923–24, pp. 143–51.

C–46.

A seedling obtained "probably from foreign seed" by Mr. T. H. Lougher in the Agricultural Experiment Station at Santiago de las Vegas, Cuba, in 1915. Obtained in July, 1925, from Dr. Gonzalo Fortún, Director of that Station. Mr. P. Richardon Kuntz wrote us on 8th June, 1925, that this cane looked very promising indeed on the red lands near San Antonio de los Baños, in the Province of Havana. On 18th July, 1925. Dr. Fortún wrote:

> "This is a cane which, in my opinion, is destined to occupy a very important place in our plantings; it matures a couple of months earlier than our Cristalina, stools well and abundantly and its sugar content is good."

The first seed of this variety brought to the Insular Station failed to germinate and more was obtained through Mr. F. S. Earle; hence there has been no time to test it out here.

Erect, good vigor, arrows freely. Stalks long, medium girth, yellowish green with purple flushing, little wax. Internodes medium length, cylindrical but sometimes slightly tumid, not staggered, furrow traces to none. Nodes nearly even; growth ring light yellow and depressed inside opposite bud; root band oblique, broad in front and narrow opposite bud; rudimentary roots 3–5 alternate rows; leaf scar glabrate, appressed behind and prominent in front: glaucous band broad tapering, constricted in front, inconspicuous; buds large, exceeding growth ring by one-third, characteristically pointed, triangular-oval, germination apical, margins very narrow with small and indistinct lobules, sparsely lannated, short apical tufts, light basal placs. Leaf sheaths subglabrate, with long, scanty, tawny hairs at back, glaucous, tinted within and without; throat and collar broad and sparsely lannated; ligule obtuse, broad at apex, 3–4 mms.

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CALVINO, EVA MAMELI DE, Y MARIO.—La Caña C. 46. Chaparra Agrícola, I, 2, pp. 22–6. June, 1924.

ROSENFELD, ARTHUR H.—Report of the Special Technologist for Cane. Ann. Rept. of the Insular Expt. Station of P. R., 1924–25.

C–7C8.

Brought by Commissioner of Agriculture Carlos E. Chardón from the Santiago de las Vegas Experiment Station of the Cuban government Both he and Mr. P Richardson Kuntz, Agronomist of the Insular Station of Porto Rico, report it as very promising looking there, it with C–35, C–46 and C.H. 64(21 being about the only promising looking Cuban seedlings. These seeds failed entirely to germinate. On 8th June, 1925, Mr. Richardson wrote from San Antonio de los Baños, in Havana Province, Cuba, that this cane looked very promising on the red lands there, hence more seed was obtained from Dr. Gonzalo Fortún, the Director of the Santiago de las Vegas Station, who reported it as the most vigorous grower of the Cuban seedlings and a good germinater, in July, 1925. Mr. Fortún stated that he has never seen a cane having better general-purpose qualities. This seed, however, arrived in very bad condition and again failed to germinate.

CH–64(21). ("Super-Uba"). See Plate II, opposite page 119; also Plate XX, opposite page 157.

A seedling obtained at the Agricultural Experiment Station, Santiago de las Vegas, Cuba, by Drs. Eva Mameli and Mario Calvino,

through fertilizing Uba cane with the pollen of D-74 in 1921. Brought to the Insular Experiment Station of Porto Rico in 1924. This cane has no appearance of a hybrid, but is typical of the North Indian canes such as Uba, Kavangire, Tekcha, Oshima, etc., as seen form the following description:

Erect, fine vigor and good stooler, arrows freely. Stalks long and slender, yellowish green with reddish purple flush and abundant grayish wax when young, changing to yellow color with reddish brown flush and black wax covering with age. Internodes long, cylindrical, enlarged at base, slightly staggered, furrow traces to none. Nodes parallel and prominent, growth ring broad, even or slightly elevated, yellowish green to concolorous; root band broad and prominent, parallel, light green to concolorous; rudimentary roots large, few and scattered, 3-4 in rows, brownish to concolorous, tendency to sprout forming aerial roots; leaf scar glabrate and appressed; glaucous band broad, inconspicuous, tapering from prominent root band to girth of internodes. Buds ovate, medium size, slightly exceeding growth ring, germination apical, margins narr.., uniform and on upper half only, sparsely lannated with short silvery hairs, very light basal placs, tendency to premature germination. Leaf sheaths subglabrate, sides glabrate, yellowish green, inner base slightly tinted with purple, glaucous, closely adherent; throat narrow, very sparsely lannated with minute white hairs, few straggling hairs at margins; collar narrow and reaching midrib, glaucous; ligule narrow at sides, abruptly enlarged and peaked at center, ligular process none. Leaf blades spreading with declining tips, narrow to medium width, dark green, minutely but uniformly serrulated at margins, sparse basal ciliation.

This cane has the same characteristic, so marked in all the North Indian canes, of suckering very late in its growth whenever there is an abundance of moisture. It apparently has one advantage over the *Uba* and Kavangire in that it does not seem to flower so prolifically or so early in the season as do these kinds.

Mr. F. S. Earle, of the Tropical Plant Research Foundation staff in Cuba, wrote us under date of 28th January, 1925:

"In Calvino's plot (Chaparra) on thin black coco subsoil land . . Uba and its allies (Cayana 10, C.II-64(21)) are not doing as well as Cristalina."

Again on the 18th August, 1925, Mr. Earle wrote:

"The supposed hybrid C-64, or C-64(21) as Calvino called it, is outgrowing Uba."

On 11th June, 1926, Mr. Earle wrote:

"On the whole, C-64 (around Herradura, in Havana Province, Cuba) has given slightly better average sucrose (in eight series of analyses) than Uba and is rather beating it in tonnage, but at the last analysis, May 8, Uba was decidedly ahead in sucrose (17 months).

Variety	Brix	Sucrose	Purity	Remarks
Uba	20.84	18.12	86 94	2nd in 20 kinds
C-64	20.04	17.85	89.07	3rd in 20 kinds

"Both were ahead of everything else in that field except B.H. 10(12)."

This variety is planted out in tonnage tests at the Station with some ten other varieties of this type and is also included in the 21-variety substation at Bayaney. In both of these plantings it has germinated most excellently and stooled tremendously.

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THE DEMERARA SEEDLING CANES

The number of Seedlings introduced from Demerara is very much less than from Barbados. Most of them have made a good record and some are among our most important kinds.

D-74.

Seedling of White Transparent (= Cristalina). While listed as a Demerara Cane because it is widely known as such and under that name has acquired a great deal of prominence in Louisiana and Mauritius, this cane is in reality one of the earliest Barbados seedlings! The late lamented Sir John B. Harrison worked conjointly with Mr. John R. Bovell when the first seedlings were produced in Barbados at the same time that Soltvedel, working independently in Java, also rediscovered the fertility of true cane seed. Shortly after the production of these seedlings and before the value of any of them had been yet definitely established—in fact, before they were given permanent numbers—Sir John B. Harrison was transferred to British Guiana as Director of Science of Agriculture, a post which he filled with distinction until his death less than a year ago, and took with him a number of the first Barbados seedlings to work with until he could start producing his now famous Demerara series, of which he is responsible for some 70,000. These Barbados

seedlings were given Demerara numbers, both D–74 and D–95 having been amongst this transferred lot.

D–74 was first imported into Porto Rico by Mr. D. W. May, Agronomist in charge of the Federal Agricultural Experiment Station at Mayagüez, from the Audubon Park Experiment Station in New Orleans, Louisiana, where it was then beginning to give most promising results as a sweet, early-maturing and slightly frost-resistant cane. In 1909 Mr. Sewall reintroduced it, from Antigua this time. It was included in the variety experiment at Aguirre in 1911 and was in cultivation in this Station from 1911 to 1916, when it disappeared, to be reintroduced some six or seven years later.

Earle states that in his experience in Cuba this kind usually gave 3 per cent more sucrose than Cristalina in December, when the crop usually begins. In the Aguirre experiments this kind came out second in tons sugar per acre, producing 66.36 tons cane, with brix, 18.55; sucrose, 15.68; purity, 84.5; tons sugar, 7.53. Station record follows description.

Erect, then recumbent, weak grower and poor stooler. Stalks long and of medium girth, green changing to yellowish-green, heavy bloom, no flush. Internodes of good length, cylindrical, nearly perpendicular, furrow none. Nodes constricted, oblique, growth-ring narrow, 2 to 4 mm., widening on outer margin of curves, even, green to concolorous; root-band wide, oblique, green to concolorous; rudimentary roots numerous and scattered, small and inconspicuous, in 4 to 6 rows, purplish to concolorous; leaf scar glabrate, appressed behind; glaucous band medium width, constricted and conspicuous. Buds medium size, 7 by 9 mm., orbicular, never exceeding growth-ring, germination sub-dorsal, margins very narrow and on upper fourth only, with sparse long hairs, heavy basal placs covering lower three-fourths, laminated along fibro-vascular bundles of scales. Leaf sheaths with sparse vestiture of short white hairs at back, sides glabrate, no tinting; throat wide, glabrate, covered with black wax, split at sides, collar wide, glaucous, reaching midrib; ligule narrow at sides, becoming slightly wider and peaked at center; short, stubby ligular process on one side only. Leaf blades erect with declining tips, medium width, about 6 cms, dark green, margins minutely and uniformly serrulated to base, some basal ciliation.

Kind	Date	Age	Tons	Brix	Sucr	Gluc	Purity
D 74 (1)	Feb 1912	Plant		18.7	16.8	0.8	89.8
D 74	Feb 1915	Plant	14.9	17.90	16.39		91.2
Cristalina	Feb 1915	Plant	22.1	17.98	16.65		92.0
D 74	May 1916	Rat	10.6	18.1	16.9		91.88
Otaheite	May 1916	Rat	12.2	18.3	17.0		92.89

(1) Highest in sucrose and purity out of 25 kinds

This cane is today suffering severely from Mosaic in Louisiana and seems doomed to extinction there, the place where it has become best known, as it was a failure under Demerara conditions. In Porto Rico since its reintroduction it has not done at all well, showing a consistently weak growth and poor ratooning qualities, while it also has the tendency to flower very early in the season—October to November—and of drying out rapidly thereafter. Planted out in tonnage experiments on good *vega* land at the station in the fall of 1925 along with most of the other Barbados canes in our collection, it has failed utterly to keep up with the majority of these and is about the weakest cane in the lot. It seems to have very little place in Porto Rican cane culture.

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D-95.

Another Barbados early seedling, like D–74, *q. v.* Imported from Audubon Park, Louisiana, in 1904 by Mr. May of the Mayagüez Station. Mr. Sewall notes having received seed from Mayagüez. In the crop of 1910 it stood highest in his tests in both brix, sucrose and purity as follows: brix, 18.4; sucrose, 17.8; purity, 96.70. It was cultivated at Guánica in 1910 and 1911, where Mr. Murphey notes that it was troubled by leaf spot. It was included in the variety plots at Aguirre in 1911, where it stood first in tons sugar per acre. Its record follows: tons cane, 68.31; brix, 18.45; sucrose, 15.78; purity, 83.7; tons sugar, 7.84. It does not seem to have been cultivated at this Station. Not seen in Porto Rico.

The remarks made under D–74 may be repeated here. This is another early-maturing kind that after making an exceptionally good record here has been completely abandoned and lost—a fact that is hard to understand, although, judging by its behavior in Louisiana, where it was always inferior to D–74 in general hardiness, with the exception of one or two of the lower river parishes, it could never have competed with such canes as B.H. 10(12) or S.C. 12/4 here.

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D-108.

Received in December, 1924, through the courtesy of Sir John B. Harrison, Director of Science and Agriculture in British Guiana. No data as yet available for Porto Rico.

Recumbent, fair vigor, good stooler. Stalks long, medium girth, green to yellow. Internodes medium length, cylindrical, not staggered, no furrow. Nodes nearly even, parallel; growth ring narrow, 2-4 mms., slightly elevated, concolorous; root band narrow, parallel, concolorous; rudimentary roots conspicuous, few and scattered, 3-4 in rows, brown; leaf scar glabrate and appressed behind; glaucous band narrow, slightly constricted and conspicuous. Buds small, 5-7 mms., not exceeding growth ring, plump, orbicular, germination subdorsal, margins narrow, lannated and on upper half only, shouldering abruptly at sides, no apical tufts nor basal placs. Leaf sheaths lannated with long tawny hairs at back, sides glabrate, tinted within and without, glaucous; throat narrow and heavily lannated with long, coarse hairs; collar medium width, reaching midrib, lannated; ligule narrow, concave above at center and convex below, no ligular process. Leaf blades spreading with declining tips, medium width about 6 cms., dark green, margins minutely serrulated abundant basal ciliation.

* D-109.

Introduced from Antigua by Mr. Sewall in 1909. It was probably also included in the direct importation from Demerara made by Central Canóvanas, though this was not so understood by Mr. Sewall. It is planted extensively in Eastern Porto Rico, especially in the districts about Canóvanas, Río Piedras, Fajardo and Naguabo. Since the outbreak of mosaic in the western part of the Island, seed cane from this eastern region has been in strong demand and this variety has been widely disseminated. It is now probably planted more largely than any other of the Demerara seedling canes. It was first noted in the Guánica reports in 1913. In 1915 there were 9 acres of it there but it has attracted no attention in that district. It has been in continuous cultivation at this Station since 1911 and seed of it has been sent to many planters.

Usually soon decumbent, good vigor and stooling, arrows, freely. Stalks long, medium diameter, red or reddish purple, heavy bloom. Internodes medium to long, somewhat barrel-shaped, or sometimes subcylindrical and enlarged below, furrow shallow, often wanting. Nodes strongly constricted; growth ring broad, usually 4 to 6 mm.,

even or nearly so, at first yellowish then dark purple or brownish purple; root band narrow, 6 to 7 mm., strongly constricted, at first yellowish but at length darker than the internode; rudimentary roots small, crowded, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, 6 to 7 mm., constricted. Buds small, oval-ovate, obtuse, 8 to 9 × 8 to 9 mm., exceeding the root band but seldom exceeding the growth ring, margin very narrow, germination apical, inconspicuous basal placs and scanty marginal and apical vestiture, sometimes sub-glabrate. Leaf sheaths with a short scanty vestiture which is usually deciduous, leaving the mature sheath glabrate, strongly tinted, glaucous; throat lannate with a scanty vestiture of longer hairs on the margins; collar well marked, reaching the midrib, often with purplish tints, glaucous or the margins sparingly lannate; ligule short, 2 to 3 mm., nearly even; ligular processes irregular or wanting, sometimes one well developed. Leaf blades spreading, flat, about 6 cm., rather dark green, the midrib sometimes purplish with age, minutely serrulate, the base even and sparingly ciliate.

This is a good general-purpose cane well adapted for general planting. It closely resembles Rayada and Cristalina in cultural characters and requirements, but seems a little better able to withstand unfavorable soil conditions. It seems to be especially well adapted to the red shale hills. It ripens a little later than Cristalina, but develops equally good sucrose at maturity. It may be planted either in fall or spring, but on account of its free arrowing should not be held over as *caña quedada.*

It seems to be a little more resistant to root disease than Cristalina, but it is perhaps even more susceptible to mosaic, once it takes it, being resistant but not tolerant. Recent observations in the Trujillo Alto district indicate that it is strongly resistant or perhaps immune to gum diseases. If this proves to be true it will add greatly to its value. It suffers severely from *Helminthosporium sacchari* leaf spot and the bundle fungus, *Plasmodiophora.*

Its record as sugar producer is only moderately good at Fajardo, averaging about 2½ tons per acre. It was largely planted there, especially in hill lands. Our highest record comes from Central Lafayette on the south coast, first in sucrose as plant cane and second as ratoons out of 7 kinds tested as follows:

Kind	Date	Age	Brix.	Sucr.	Purity
D-109	April 1914	Plant.......	21.8	20.8	93.5
D-109	February 1916 ..	2nd. Rat ...	21.7	19.5	89.8

As reported in Circular 8, it stood: plant cane, 36 to 56 tons; total for 3 crops, 78 72 tons; brix, 18 42; sucrose, 14.98; purity, 87.0. This would indicate an average yield of 2.89 tons sugar per acre for each of the three crops. Other analyses follow·

Kind	Date	Age	Arr	Extr	Brix	Sucr	R S	Purity	Fiber
D 109	12 10 20	Rat 10 mo	No	73 3	14 23	9 93	3 22	69 78	8 54
Rayada	12 10 20	Rat 10 mo	No	71 1	15 83	13 45	1 76	84 96	8 08
D 109	12 30-20	Rat 9 mo	No	70 0	18 94	16 38	0 91	86 58	10 80
D 109	12 30 20	Rat 9 mo	Yes	67 3	20 04	17 85	1 15	89 70	18 08
D 109	12 24 20	Pla 14 mo	Yes	61 1	19 58	17 46	0 67	89 17	14 0
Cristalina	12 24 20	Pla 14 mo	No	65 7	18 88	17 08	0 52	90 65	18 72
D 109	2 1 21	Pla 16 mo	No	65 2	18 0	16 33	0 59	90 72	11 18
D 109	2 4 21	Pla 16 mo	Yes	64 0	17 5	15 34	0 62	87 65	12 24
Cristalina	2 4 21	Pla 16 mo	Yes	65 2	18 40	17 27	0 65	93 85	11 08
D 109	4 1 22	Pla 12 mo	Yes	69 2	19 51	17 28	1 18	88 56	Station
Cristalina	4 1 22	Pla 12 mo	No	63 6	18 61	17 [illegible]	0 70	92 50	Station
D 109	5 7 23	Rat 12 mo	Yes	[illegible] 0	19 90	18 87	0 72	92 31	Station
Cristalina	5 7 23	Rat 12 mo	No	[illegible]	20 80	19 92	0 54	95 77	Station
D 109	1 20 23	Pla 18 mo	No		19 60	16 66		85 00	Aguirre
D 109	1 20 23	Pla 14 mo	No		19 30	16 31		88 70	Aguirre
D 109	3 20 23	Pla 15 mo	No		18 10	14 41		78 40	Aguirre
D 109	12 2 24	Pla 16 mo	No		1[illegible] 10	1[illegible] 13		80 80	Aguirre
D 109	12 13 24	Pla 16 mo	No		16 20	13 29		82 60	Aguirre
D 109	5 16 23	Pla 14 mo	No			16 12		86 24	Hatillo
Cristalina	5 16 23	Pla 14 mo	No			19 27		94 36	Hatillo

In the last experiment at Hatillo Fruit Farm, corresponding to the last set of figures above, D–109 produced 25 7 tons of cane and 3 tons of sugar per acre, against 16 and 2 33 tons respectively for Cristalina on those red shaly hills Earle considers this variety of doubtful value for the South Coast

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D–116

Seedling of White Transparent

Introduced by Central Canóvanas As planted in Porto Rico this was the same as D–625, which see There was some doubt as to which of these kinds is really represented here, but the identity of the two have now been thoroughly established by the introduction of the two from pure cultures in Demerara in December, 1924 As a matter of fact, the true D–116 does not resemble D–625 in the least, being much more similar in general appearance to D–117. In a letter received from Sir John B Harrison, under date of 26th

September, 1923, he had the following to say in regard to this variety:

"D-116 when raised with us, and it is still under cultivation in our experimental fields, very clearly resembles D-117, differing from it only in colour. Both of these canes were produced by us from one arrow of a White Transparent cane of a strain obtained from St. Kitts and then termed Caledonia Queen. The colour of D-116 may be described as a dark green, with usually a patched dirty-looking soiled surface changing through soiled olive-green and light-green to a yellowish-green when mature. Where exposed to the sun the cane has a horn-yellow tinge and is blotched with large brownish red splotches. There is an irregular distribution of 'bloom' over some of the internodes, the distribution varying greatly, some internodes being nearly covered with 'bloom' whilst others show very little. On stripping the adherent leaf sheaths from the upper joints some are seen to be faintly striped, a characteristic of the majority of canes of White Transparent parentage, while others are of uniformly light-green colour. The lowest internodes of the cane, dark green in colour, are short and cylindrical. The higher internodes become longer with growth until somewhat over the medium length. In some cases the joints are straight and in others somewhat staggered but always tend to become markedly constricted as the cane matures; while the canes generally tend to rapidly taper off in diameter with increasing length. In our trials we found it very difficult indeed to distinguish between D-116 and D-117, the latter however, as a rule gave juice of somewhat higher saccharine content and purity than did the former. Over several crops on large-scale trials their yields of cane and of sugar were practically identical, the differences as a rule being well within the range of probable error. It is now, however, many years since we ceased to cultivate D-116 on a large scale plot. The planters here did not care for either D-116 or D-117, as these canes when grown on our heavy soils tended to be very fibrous, while their yields rapidly decreased when cultivated as ratoons. . . . . Even in Demerara there was confusion on one plantation between the varieties numbered D-116 and D-625, but when I examined specimens of the cane growing there those termed 116 were typical 625."

Erect, at length recumbent, good vigor, fine stooler. Stalks long, medium girth, green changing to yellow like D-117 on exposure to sun, some bloom and flush. Internodes long, cylindrical, slightly enlarged at base, slightly staggered; furrow traces to none. Nodes slightly enlarged, oblique; growth ring medium width, 3-5 mms., elevated, concolorous; root band wide, oblique and concolorous; rudimentary roots abundant, large and rather crowded, in rows 3-5, brownish; leaf scar glabrate and appressed behind; glaucous band broad, slightly constricted, inconspicuous. Buds medium size, 7-9 mms., plump, triangular ovate, not exceeding growth ring, germination apical, margins narrow and on upper half only, lannated, very short apical tuft, light basal placs. Leaf sheaths subglabrate, slightly

tinted inside and out, glaucous; throat indistinct, broad, lannated with coarse hairs; collar narrow, dark reaching midrib, glaucous; ligule narrow except at center, concave below, nearly even above, ligular process 2–3 cms., long on one side only, lanceolate. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, minutely and uniformly serrulated except at base, very sparse basal ciliation.

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*D–117. See Plate XXI, opposite page 169.

Imported from Audubon Park, Louisiana, in 1904 by Mr. May of the Mayagüez Station. It was mentioned in the Guánica reports for 1910 as among the best canes for that district and was until 1922 more widely planted there than any other kind. It was included in the variety test at Aguirre in 1911. Fajardo reports for 1913 mention it among the three best canes for that district, but at present it is hardly planted there It has been sent out from here very widely. It is probably more widely planted in Porto Rico than any other Demerara seedling except D–109.

Strictly erect, good vigor and stooling, arrows freely and early. Stalks long, medium diameter, green then yellowish, flush none or very slight, little or no bloom. Internodes medium to long, straight or somewhat staggered, cylindrical or sometimes larger below, furrow slight or none. Nodes scarcely constricted, somewhat oblique; growth ring narrow, brownish, prominent, the widest part of the stalk; root band oblique, 8 to 10 mm., light green, tapering downward; rudimentary roots crowded in about 4 rows, leaf scar glabrous, appressed behind; glaucous band slightly constricted, about 8 mm., conspicuous. Buds large, ovate, obtuse about 14 $\times$ 14 mm., exceeding the growth ring by one-fourth, margin narrow, uniform, germination apical or subapical, often developing, with short basal placs and scanty short vestiture. Leaf sheaths with scanty short appressed vestiture often becoming nearly glabrate, green somewhat glaucous; stained with purple at base within; throat densely lannate and with a conspicuous vestiture of long hairs on the margins and behind the ligule; collar conspicuous, dark brown, reaching the midrib, lannate on the margins; ligule short, 2 to 3 mm., nearly even; ligular processes

unequal, one usually strongly developed often 2 cm. long, acute, the other usually wanting. Leaf blades suberect, crowded, flat, somewhat two-ranked, dark green, 6 to 7 cm., wide, very minutely serrulate, the base even, not ciliate.

This is one of the best of these canes for general planting in Porto Rico. It thrives on a great variety of soils. On the low compacted *vegas* it will give a tonnage almost or quite equal to Yellow Caledonia. In the red shale hills it will decidedly exceed that kind. It is, however, late in maturing and should always be planted in the fall as *gran cultura*. It arrows too freely to be held over as *caña quedada*, on long crop.

It is decidedly more resistant to both root disease and mosaic than Cristalina and Rayada and it is usually a good ratooner. Its resistance to gum disease is not fully determined but it seems to be good. At least no diseased canes of this kind have been found, although it occurs in mixed plantings where the Otaheite is heavily infected by gumming.

Early in the season it is poor in sucrose, especially in the stalks that have not arrowed. When fully mature it develops about the same per cent of sucrose as Cristalina. It should never be planted in mixed plantings where it is likely to be cut too green. Its record at Aguirre in 1911 was as follows: tons cane, 69.821; brix, 17.09; sucrose, 13.52; purity, 79.01; tons sugar, 6.59. It was third in tonnage among the kinds tested, but these plots were cut in January and this cane was evidently still too green to have developed its best sucrose. Mr. Sewall reports that in 1910 this cane stood second in sucrose and purity by mill test at Naguabo. Its record was: brix, 16.7; sucrose, 15.70; purity, 94.0. The Fajardo reports were usually low, seldom averaging more than 3 tons sugar per acre. At Central Lafayette, April 1914, as plant cane it gave: brix, 21.1; sucrose, 18.6; purity, 88.1. As second ratoon in February 1916, it gave: brix, 20.4; sucrose, 18.0; purity, 88.2. In Guánica, December 1920; a field of 12.85 acres of *gran cultura* gave, tons cane, 49.715; brix, 15.27; sucrose, 13.24; purity, 84.22; tons sugar, 5.23. Here again the cane was evidently too green. At this Station, as reported in Circular 8, it stood second in tons cane as plant cane, but fell to sixth place in total tons from three crops. The record follows: tons cane as plant, 57.23; total for 3 crops, 99.55; brix, 17.50; sucrose, 15.92; purity, 90.9. Cristalina record in these tests was tons plant cane, 43.87; total for 3 crops, 77.52; brix, 16.60; sucrose, 15.02; purity, 90.5. This would figure an average of 3,972 tons

sugar for each of the three crops for D–117 and 2.91 tons for Cristalina. Some more recent analyses are:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Puri.	Fiber
D-117	12-30-20	Rat. 9 mo.	No	69.18	15.18	12.15	1.69	80.80	11.58
D-117	12-30-20	Rat. 9 mo.	Yes	67.2	16.58	13.66	1.71	82.52	11.80
D-117	12-20-20	Rat. 14 mo.	No	67 6	16.30	13.78	0.72	84.54	10.3
D-117	12-20-20	Rat. 14 mo.	Yes	68 7	17 20	15 08	0.21	87.88	10 6
Cristalina	12-20-20	Rat. 14 mo.	No	70 0	17 50	15.58	0.28	88.74	9 60
D-117	1-26-21	Rat. 15 mo	No	67.5	15.55	12.94	1.17	83.21	10.40
D-117	1-26-21	Rat. 15 mo.	Yes	67 0	18.30	15.82	0 76	86.44	11.00
Cristalina	1-26-21	Rat. 15 mo.	No	70 8	17.85	16.14	0 88	90.42	11 22
D-117	2-4-21	Pl. 16 mo.	No	64 7	17.20	14.71	1.50	85.52	12.60
D-117	2-4-21	Pl. 11 mo.	Yes	61.5	17.50	15.20	1 18	86 85	12.82
Cristalina	2-4-21	Pl. 16 mo.	Yes	65 2	18 40	17.27	0.65	93 85	11.88
D-117	4-6-21	Pl. 18 mo.	Yes	68.0	19.45	18.02	0.265	93.48	10.47
D-117	4-8-22	Pl. 12 mo.	Yes	66.7	19.51	16.87	1.57	88.90	Station
Cristalina	4-8-22	Pl. 12 mo.	No	63 6	18.61	17.22	0.70	92.50	Station
D-117	5-8-23	Rat. 12 mo.	Yes	....	20.55	19 92	0.48	94.01	Station
Cristalina	5-8-23	Rat 12 mo.	No	... ..	20 80	19.92	0.54	95.77	Station
D-117	1-24-23	Pl. 18 mo	No	....	19.90	16.76	....	84.20	Aguirre
D-117	2 23-23	Pl. 14 mo.	No	....	19 70	15.70	....	79.70	Aguirre
D-117	3-22-23	Pl. 15 mo.	No	... .	19.00	15.52	....	81.70	Aguirre
D-117	4-21-23	Pl. 16 mo.	No		18.10	15.89		85.00	Aguirre
				Tons cane per acre			Tons sugar per acre		
D-117	8-29-24	Pl. 22 mo.	Yes	50 40	... ...	16.02	5 88	86 90	Hatillo
Rayada	8-29-24	Pl 22 mo	No	6 56	.. .	16.67	0 80	88.20	Hatillo
D-117	4-11 23	Rat. 15 mo.	Yes	....	21.00	19.37	......	92.28	Station
BH10(12)	4-11-23	Rat. 15 mo.	No	... ..	24.25	23.20	.... ..	96 26	Station
D-117	6-7-24	Pl. 11 mo	Yes	.... ..	18 60	15.80	....	84.24	Hatillo
BH10(12)	6-7-24	Pl. 11 mo	No	....	19.20	16.82	....	87.60	Hatillo
D-117	11-7-24	Pl. 11 mo.	Yes	.....	13.50	77 54	.. ...	57.84	Station
D-117	12-8-24	Pl. 12 mo.	Yes	....	15 20	11 91	......	78.36	Station
D-117	1 9-25	Pl. 18 mo.	Yes	...	16 05	13.06	.....	81.37	Station
D-117	1-9-25	Pl. 17 mo.	No	26 79	17 86	15.63	3 11	87.50	Aguirre
D-117	2-9-26	Pl. 16 mo	Yes	40 50	11.98	12.70	3.76	85.50	Station
BH10(12)	2-9-26	Pl. 16 mo.	No	51 81	17.43	15 50	6.05	86.06	Station
D-117	5-27-26	Rat. 12 mo.	No	20 68	21.05	17.84	....	84.87	Station
H-109	5-27-26	Rat. 12 mo.	No	25 00	18.95	16.70	.. ...	88.10	Station

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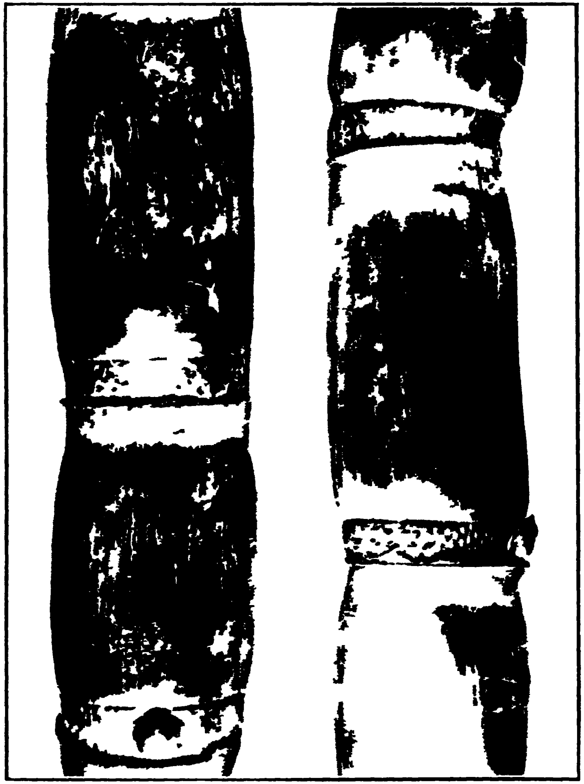
*** D–147.**

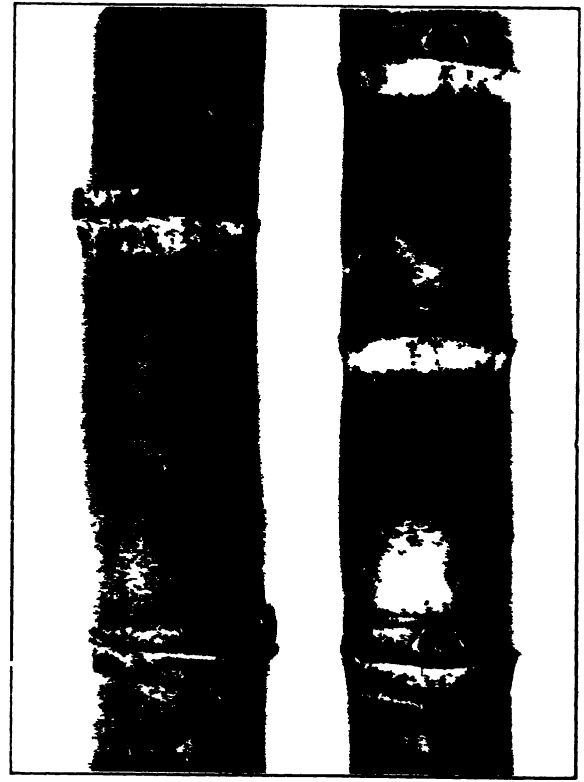
This kind is present in the experimental plots at Fajardo. Seed was brought to this Station in November, 1919. But failed to germinate. Not seen elsewhere. We find no record of its introduction. Earle obtained a little seed from Fajardo in 1920 and obtained one stool, which proved to be typical Yellow Caledonia. A row of this variety was planted at the Insular Station for study and comparison in November, 1924, and turned out to be only Yellow Caledonia, hence its cultivation here as D–147 has been finally abandoned.

D–216.

When the writer arrived at the Insular Experiment Station in



D 357



D 625

1923, this cane was growing well and being distributed under this number, but a close study by the writer and Mr. Luis Serrano has shown that this is just another case of mixed numbers, as the cane is identical in every respect D-448, which see.

D-247.

Obtained, on recommendation of Mr. P. Richarson Kuntz, Agronomist of the Insular Experiment Station of Porto Rico, from Dr. Gonzalo Fortún, Director of the Cuban Experiment Station at Santiago de las Vegas, in July, 1925. It arrived in bad condition and failed to germinate; hence Dr. Fortún was requested to make us another small sending, but the seed again came wrapped only in newspaper and arrived in such a dried out condition that no germination could be secured. Dr. Fortún wrote the author in regard to this variety on 18th July, 1925:

"The D-247 was recommended to you undoubtedly on account of the facts I am now going to relate: Along about 1911 or 1912 we sent to the Quinta de los Molinos, where our agricultural school is located, some 60 varieties of cane. Some years later, probably about 1919, I discovered mosaic in this field, although nothing was done to destroy the diseased varieties, hence all the varieties there suffered from the attacks of the disease according to their resistance to same. Last May I visited this field in order to obtain some varieties which had been sent from the Experiment Station and had since been lost from our collection; many had been completely destroyed by mosaic, others were very heavily infected and one was noticeably, on account of its vigor and remarkable development. I was able to determine this outstanding one as D-247. In spite of the fact that its leaves showed all the characteristic markings of the disease. its development had not been impeded, which fact forces me to the provisional conclusion that, in spite of being susceptible to mosaic, this disease does not affect its development materially."

D-355.

Noted by Cowgill as occurring at Dolores, Río Grande, July 15, 1912. No other record of this cane.

Not seen.

* D-357. See Plate XXII, opposite page 185.

This cane figured in Cowgill's notes as occurring at Fajardo in 1913. We have no record of its introduction. Seed was brought from Fajardo to this Station in November, 1919. It was included in the Santa Rita immunity experiment where it suffered considerably from root disease and top rot and was severely attacked by mosaic. It seems to have no special value.

Erect, good vigor, poor stooler. Stalks long and of good girth, yellowish-green basal color, heavily overlain with red, changing to purple, heavy bloom. Internodes medium to long, appressed at sides and noticeably enlarged at base, slightly staggered, no furrow.

Nodes constricted and oblique; growth-ring wide, 4 to 6 mm., greenish to concolorous, elevated; root-band narrow, yellowish-green to concolorous, overlaid with wax covering; rudimentary roots small, numerous, crowded and inconspicuous, in rows 4 to 5, purplish to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band narrow, constricted, inconspicuous. Buds medium to large, 7 by 9 mm., orbicular, reaching growth-ring, germination sub-apical, margins narrow, on upper half only, abruptly shouldered at sides, lannated, very short, but broad, apical tuft, heavy basal placs, heavy lannation along fibro-vascular bundles. Leaf sheaths sub-glabrate at back, sides glabrate, heavily tinted without and slightly within, somewhat glaucous; throat wide, dark gray, lannated with short appressed hairs, some straggling coarse hairs at sides; collar broad, dark colored, reaching midrib, lannated with tiny velvety hairs, reaching midrib; ligule narrow, 2 to 4 mm., nearly even, no ligular process. Leaf blades spreading, broad, 8 to 10 cms., not flat, dark green, margins minutely serrulated except at base, scanty basal ciliation.

This is a fine-looking and very sweet cane, but it is a very poor stooler, the only way to get results with it being to plant very thickly, as Mr. W. C. Dreier does at the Hatillo Fruit Farm. It made a bad failure in Earle's trials at Aguirre during 1921–23, but at the Hatillo Fruit Farm, handled as indicated above, on poor shaly red clay hillsides, it has the following record from cane ground at Central Victoria on 16th May, 1923:

Variety	Tns cane per acre	Purity	Sucrose	Yield factor	Tns sugar per acre	Age
D 357	21 70	90 02	19 04	14 09	3 06	Pl 14 months
Cristalina	16 00	94 36	19 27	14 59	2 33	Pl 14 months
D 357	32 04	89 50	16 61	12 15	3 89	Rat 10 months
D 357	26 87	(Average over two years)			3 47	

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VEVE, RAFAEL A.—Our Experience with Cane Varieties. Mem. Assn. Sugar Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922.

D-419.

Received in December, 1924, through the courtesy of Sir John B. Harrison, Director of Science and Agriculture in British Guiana and the originater of this variety. No data as yet available as to the conduct of this cane in Porto Rico.

Erect, at length recumbent, good vigor, fine stooler. Stalks long,

medium girth, green to yellow, abundant bloom. Internodes long, cylindrical, slightly enlarged at base, appressed laterally to bud, slightly staggered, furrow broad and shallow. Nodes nearly even, oblique; growth ring medium width, 3–5 mus., slightly elevated, concolorous; root band oblique, concolorous; rudimentary roots few, large, scattered, 3–4 in rows, green changing to purple; leaf scar glabrate and appressed behind; glaucous band broad, constricted and inconspicuous. Buds medium to large, 8–10 mms., triangular ovate, exceeding growth ring by one-third, germination apical, margins broad, flat, uniform, shouldering at base, glabrate, short and scanty apical tufts, light basal placs. Leaf sheaths with abundant dorsal vestiture of short, tawny, deciduous hairs, sides glabrate; slightly tinted inside and out, glaucous; throat broad, dark and well defined, covered with short appressed hairs, straggling hairs at margins, tendency to split; collar wide and well defined, reaching midrib, lannate; ligule narrow, nearly even, no ligular process. Leaf blades spreading with declining tips, broad, 7–9 cms., dark green, minutely serrulated at margins, some basal ciliation.

* D–433. See Plate II, opposite page 119.

We have no record of the introduction of this cane. In Mr. Crawley's notes under date of June 24, 1913, it is mentioned in a list of the best canes for the Fajardo district given by Mr. McConnie. It is now being planted at Fajardo more largely than any other variety and it is giving heavy average tonnage and sugar per acre. Seed was brought from Fajardo to this Station in 1918. It is doing well here, but apparently no better than D–117. It has been seen elsewhere in the Santa Rita immunity experiment, where seed was sent from Fajardo, at Central Carmen, where it was a failure, at Hatillo Fruit Farm and at Centrals Mercedita de Yabucoa and Aguirre.

Erect or at length declined, good vigor and stooling, seldom arrows. Stalks long, medium stout, green with a slight pink flush completely covered by a dense gray bloom Internodes long, cylindrical or somewhat enlarged below, staggered, furrow none. Nodes constricted, oblique; growth ring narrow, even or a little sunken, greenish; root band about 8 mm., concolorous; rudimentary roots large but indistinct, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band almost completely obscured by heavy bloom of the internode. Buds broadly-ovate, obtuse, about 12 to 14 × 12 to 14 mm., exceeding the growth ring by one-fourth, margin medium width, uniform, germination subdorsal, basal placs short, marginal vestiture heavy, ending in a pronounced apical tuft and ex-

tending down the back of the bud to the germination point. Leaf sheaths with a moderate vestiture of long, stiff, assurgent hairs, greenish, densely glaucous; throat lannate and with a sparse vestiture of long hairs on the margins and behind the ligule; collar narrow, reaching the midrib, pallid, glaucous, slightly lannate on the margins; ligule about 3 mm., margin fimbriate-ciliate; ligular processes none. Leaf blades erect, the tips declined, broad, flat or the margins slightly revolute, reaching 8 cm. or more, dull blue-green, serrulate to the sparingly ciliate base.

This cane seems to be particularly adapted to the low, compact maritime *vegas* and the yellow clay alluviums on the northeast coast, where Rayada and Cristalina have failed so badly. It grows fairly well on the red shale hills, but seems to have no advantage there over a number of other canes. It could be used to advantage wherever Yellow Caledonia is being planted, for it will yield equal tonnage and give better sucrose. It is best planted in the fall as *gran cultura,* though it can be used for spring planting. It arrows so little that it would probably stand over well for long crop or *caña quedada,* but this has not been tested.

It was included in the Santa Rita immunity tests but the results were not conclusive It seemed, however, to have good resistance to mosaic and it certainly resists root disease and ratoons well, especially on low compact lands.

At Fajardo it has given the following average results in tons of sugar per acre. In 1915, 3.73 tons; 1916, 3 47 tons; 1917, 3.44 tons, and in 1919, 3.75 tons More recent analyses here as follows:

Kind	Date	Age	Extr	Brix	Sucr	R S	Puri	Fiber
D 433	11 29 20	Rat 13 mo	67 9	16 67	12 56	2 48	75 66	10 18
Ave of 5 Cheribon	11 29 20	Rat 13 mo			13 68	1 67	87 88	12 29
D 433	1 10 21	Rat 14 mo	65 9	15 10	13 08	1 81	86 29	10 91
Cristalina	1 10 21	Rat 14 mo	71 4	17 90	15 34	0 64	86 67	12 01
D 433	2 23 21	Rat 16 mo	72 2	18 90	15 46	1 49	86 46	11 12
Cristalina	2 23 21	Rat 16 mo	71 4	18 90	17 40	0 30	92 06	12 58
D 433	4 [illegible] 21	Pl 18 mo	67 1	19 60	18 18	0 58	92 24	11 84
D 433	1 20 23	Pl 18 mo		20 00	16 62		83 10	Aguirre
D 433	2 20 23	Pl 14 mo		20 50	16 59		80 90	Aguirre
D 433	8 19 23	Pl 15 mo		20 50	17 11		83 60	Aguirre
D 433	4 18 23	Pl 16 mo		19 10	16 19		84 80	Aguirre
D 433	2 9 26	Pl 16 mo		13 95	11 10		79 60	Station
BH 10(12)	[illegible] 9 26	Pl 16 mo		17 43	15 00		86 06	Station

In the tonnage experiment at the Station, in comparison with BH-10(12) and fourteen others of our best canes, D-433 stood sixth in production of cane per acre, but only thirteenth in sucrose and

eighth in production of sugar per acre, producing 52.22 tons of cane and 4 tons of sugar per acre, in comparison with 54.81 and 6.05, respectively, for the BH 10(13), which stood fourth in tonnage of cane per acre, fourth in sucrose content and second in production of sugar per acre. Earle considers that this variety did not come up to expectations in Aguirre. The following letter from Mr. F. Colón Moret, Chief of the Agronomical Laboratory at Central Mercedita de Yabucoa, gives the results synthetically as obtained at that Central during the crop of 1923 with this variety:

CENTRAL MERCEDITA
THE YABUCOA SUGAR COMPANY
YABUCOA, PORTO RICO

JULIO 17, 1924.

SR. ARTHUR H. ROSENFELD,
Tecnólogo Especial,
Estación Experimental Insular,
Río Piedras, Porto Rico.

MUY SR. N. Y AMIGO:

Tenemos el gusto de informarle a continuación los resultados obtenidos por nosotros durante el pasado cosecho, con la caña D-433:

COLONIA "INGENIO"

Caña	D-433
Cuerdas	28.33
Toneladas de caña	1,189.91
Toneladas de caña por cuerda	42
Siembra de Gran Cultura	
Análisis del jugo normal:	
Brix	16.32%
Sucrosa	12.78%
Pureza	78.30%
Rendimiento en azúcar 96°	9.124%
Tons de azúcar 96° por cuerda	3.832

COLONIA "ISLETA"

De esta colonia molimos cañas de gran cultura y de retoños, pero debido a que no hemos podido determinar cuáles análisis corresponden a las cañas de gran cultura y cuáles a las de retoños, hemos aplicado el promedio de los análisis al total de la caña molida obteniendo los siguientes resultados:

Caña	D-433
Cuerdas	100.75
Toneladas de caña	3,203.12
Toneladas de caña por cuerda	31.79
Siembra de gran cultura	
Análisis del jugo normal:	
Brix	16.38%
Sucrosa	12.65%

Pureza	77.89%
Rendimiento en azúcar 96°	8.948%
Toneladas azúcar por cuerda (96°)	2.845%

Tendremos mucho gusto en suministrarle cualquiera otra información que Ud. interese.

Sin otro particular por el presente, nos suscribimos de Ud. attos. ss. ss. y amigos,

CENTRAL MERCEDITA.
F. COLÓN MORET,
Jefe, Laboratorio Agronómico.

REFERENCES

VEVE, RAFAEL A.—Our Experience with Cane Varieties. Mem. Assn. Sug. Tech. of Porto Rico, I, 1, pp. 28–31; June, 1922.
Idem.—Monthly Reports of the Fajardo Experiment Sta. 1923–26.

D-436.

Received in December, 1924, through the courtesy of Sir John B. Harrison, Director of Science and Agriculture in British Guiana and the originater of this variety. No data as yet available as to the conduct of this cane in Porto Rico.

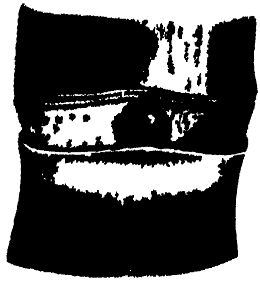
Recumbent, fair vigor, good stooler. Stalks long and of good girth, green to yellow, heavy dark wax deposit. Internodes long, tumid, slightly staggered, no furrow. Nodes slightly constricted, oblique; growth ring narrow, 2–4 mms., slightly elevated, concolorous; root band wide and oblique, concolorous; rudimentary roots few, small and scattered, 4–5 in rows, purplish to brown; leaf scar glabrate and appressed behind; glaucous band constricted, broad and inconspicuous. Buds extremely small, 4–6 mms., plump, never reaching growth ring, orbicular to keystone shaped, germination subapical, margins narrow, flat, on upper half only, purple, glabrate, no apical tufts, light basal place. Leaf sheaths extremely lannated at back and sides, green, inner base heavily tinted with purple, slightly glaucous; throat medium width, indistinct, lannated with short appressed hairs; collar wide, reaching midrib, glaucous; ligule narrow except at center, where lower side is concave and nearly even above, ligular process none. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, margins serrated almost to base, some basal ciliation.

* D-448. See Plate III, opposite page 191.

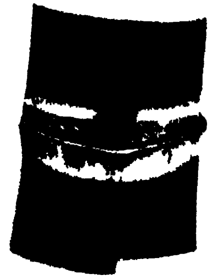
This cane was at one time considerably planted at Fajardo, but we have no data concerning its introduction. It seems to have been first planted at this Station in the spring of 1918, presumably with

PLATE III

D 448

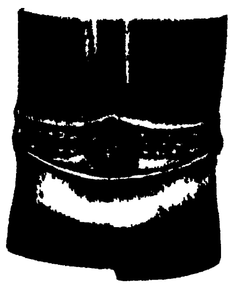


D 504



D. 1135

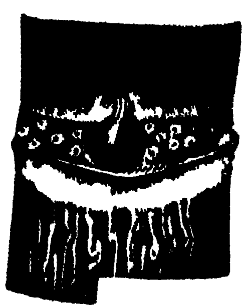
F C 214



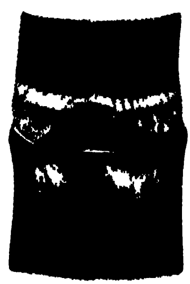
F C 306

H 109

Jamaica 72



E. K. 28



M 36 (POJ)

Illustrations by
Mario BRAU.

seed from Fajardo. It has been seen elsewhere at the Hatillo Fruit Farm, Mr. Dreier having obtained the seed from Mr. Earle, and at Aguirre, where Mr. Earle also took seed from the Station.

Erect or at length somewhat decumbent, good vigor and stooling, arrows, frequently. Stalks long, medium stout, dull purple fading to dirty brown on maturity, heavy bloom. Internodes medium length, straight or nearly so, cylindrical, or enlarged below, furrow none. Nodes scarcely constricted, somewhat oblique; growth ring broad, a little sunken, greenish or yellowish; root band 8 to 10 mm., greenish: rudimentary roots small, obscure, purplish, crowded in 4 or 5 rows; leaf scar glabrous, appressed behind; glaucous band 8 to 10 mm., scarcely constricted, not conspicuous. Buds broader than long, obtuse, plump, about 14 to 15 × 12 mm., not exceeding the growth ring; margin narrow, uniform, germination dorsal, basal place, moderate, marginal vestiture of medium length hairs and lines of short, white, appressed hairs along all of the vascular bundles of the bud scales. Leaf sheaths with a short, scanty appressed vestiture when young, usually glabrate with age, glaucous, strongly tinted; throat lannate and with a vestiture of rather short whitish hairs; collar reaching the midrib, pallid, lannate with short white hairs; ligule 3 to 4 mm., even; ligular processes none. Leaf blades suberect, the tips drooping, flat, about 7 cm. wide, medium dull green, serrulate to the base, not ciliate.

This cane is not being extended at Fajardo, where it was not considered fully satisfactory. Here and at the Hatillo Farm it is very promising, especially on hill lands. Apparently it needs open, porous soils. It should be tried on the red coral lands. It seems to mature early and promises to be useful for spring planting.

It was not included in the Santa Rita immunity experiments and but little is known regarding its disease resistance.

At Fajardo its record in sugar production is poor, being only 1.61 tons per acre in 1916, 1.87 tons in 1917 and 2.69 tons average on an area of 23 acres in 1919. More recent analyses here are as follows: Its promise of tonnage is better than the average.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
D-448	1-5-21	Pl. 15 mo.	Yes	65.6	18 58	15 96	1 89	86 18	12.86
Cristalina	1-5-21	Pl. 15 mo.	No	66.6	16.96	15 85	0.56	90.56	11.85
D-448	2-9-21	Pl. 16 mo.	No	65.6	18.40	16 51	0 87	89 72	13 07
Cristalina	2-9-21	Pl. 16 mo.	No	68.7	16.20	13 85	0 95	85.49	11.30
D-448	4-6-21	Pl. 18 mo.	No	69.4	17.80	15.14	0.65	90.40	12.94

The following analyses have been obtained from 1923 to date:

Variety	Date	Tns. cane per acre	Age	Brix.	Sucr.	Purity	Location	Tns. sug. per acre
D-448	8-19-23	....	G. C. 18 mos..	20.40	17.18	84 10	Aguirre	....
D-448	Jan., 1925	... .	G. C. 16 mos..	16.50	13 58	81.90	Aguirre	4.35
D-448	5-7 23	....	G. C. 16 mos	20 70	19.96	96 48	Exp. Sta.	....
Cristalina....	5-7-23	....	G. C 16 mos.	20 80	19.92	95.77	Exp. Sta.	....
D-448	Mar., 1924	....	G C. 22 mos	....	16 16	87 60	Trujillo Alto	3.36
Rayada......	Mar., 1924	. ...	G. C. 22 mos .		16 67	88.20	Trujillo Alto	0.80
D-448	11-7-24	. .....	G. C. 14 mos .	15 75	12 64	80.25	Exp. Sta.	....
D-448	2-9-26	48.20	G C. 16 mos	14 40	11.82	82 9	Exp. Sta.	3.66
BH10(12)	2-9-26	54.81	G. C. 16 mos..	17 48	15.00	86.06	Exp. Sta.	6 05
D-448	5-27-26	26.66	Rat. 13 mos ..	20.24	18.07	89.28	Exp. Sta.	....
H-109	5-27-26	25.00	Rat. 12 mos	18.95	16 70	88.10	Exp. Sta.	....

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ROSENFELD, ARTHUR H.—Annl. Rept. for the Year 1923–24. *Ibid*, pp. 62–8.

*** D–504.** See Plate III, opposite page 191.

This kind occurred in the variety plot at Fajardo, but there is no record as to its introduction; seed was brought from there to the Station in November, 1919. A thirty-acre field of it was found by Mr. Earle at Río Grande under the name of Java–133 and it also occurred at Humacao as Java–101. Seen elsewhere, at Hatillo Fruit Farm and at Aguirre. A very similar, but distinct, cane occurred at Central Fortuna, Ponce, which was known as "Caña de Vino".

Erect, or at length decumbent, vigorous, good stooler, seldom arrows. Stalks medium length, stout, purple fading to olive, light bloom. Internodes short to medium, stout, strongly enlarged below, subconic, furrow none. Nodes constricted, oblique; growth ring medium to broad, conspicuously elevated, brownish then olive; root band 6 to 8 mm., greenish, tapering downward; rudimentary roots large, brownish, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band constricted, about 8 mm., well marked. Buds small, broader than long, obtuse, plump, about 9 × 8 mm., not reaching the growth ring, margin medium, uniform, germination dorsal, short basal plaes and scanty marginal and apical vestiture. Leaf sheaths with abundant, coarse, assurgent vestiture, glaucous, purplish, usually splitting, throat densely lannate and with longer whitish hairs on margins and behind ligule; collar broad reaching the midrib, pallid but with reddish tinge, glaucous, the margins faintly lannate; ligule long, reaching 5 mm. at center, minutely fimbriate; ligular processes none. Leaf blades suberect, flat broad, 7 to 9 cm.,

dull bluish-green, the midrib often purplish with age, sharply serrulate to the base, sparingly ciliate.

This is a very promising cane but it has not been sufficiently tested to warrant a positive opinion. It has attracted no attention except at the one farm at Río Grande, where it was rapidly extended and at the Hatillo Fruit Farm, where it is doing well. On the Station grounds it has done especially well on the red shale hills, but it has also been satisfactory in low lands. It grows late and has the appearance of a late cane, but the analyses show that it develops sugar early. It is certainly worthy of careful study.

It was in the Santa Rita immunity experiment, but a poor stand was secured and it was in the short list of those which did not contract the mosaic. Nothing is, therefore, really known as to its disease resistance.

The following is its only record for sucrose:

Kind	Date	Age	Extr.	Brix	Sucr.	R. S.	Purity	Fiber
D [illegible]	[illegible]	[illegible]	69.2	[illegible]	[illegible]	[illegible]	[illegible]	7.39
Av. of 5 Cheribon	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.77	[illegible]	11.60
Cristalina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.0
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	Station
Cristalina	[illegible]	[illegible]	[illegible]	[illegible]	17.2	[illegible]	[illegible]	Station
D [illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
Cristalina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]
P. R. [illegible]	[illegible]	[illegible]		[illegible]	[illegible]			[illegible]
D [illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]

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VEVE, RAFAEL A.—Our Experience with Cane Varieties. Mem Assn. of Sug. Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922.

***D 625.** See Plate XXII, opposite page 185.

Introduced from Antigua in 1909 by Mr. Sewall. Probably previously introduced by Mr. Marr of Canóvanas as D–116. Nowhere now grown in pure cultures but abundantly present in mixed plantings in all of the Island, especially in the eastern districts. It was in cultivation at this Station from 1911 to 1916, but had disappeared from the collections until brought in from various sources during 1919.

Erect or at length decumbent, very vigorous, a strong stooler, arrows freely. Stalks long, medium stout, green then yellow, no

The following analyses were made of this class of 14-month-old cane and of BH–10(12) of the same age from the Hatillo Fruit Farm on 14th May, 1926:

D 625 N F	14 months	19 15	16 72	0 72	87 11
BH10 (12)	14 months	18 85	16 80	0 35	89 12

D–689.

Another of the promising varieties received in December, 1924, from the originater of this variety, Sir John B. Harrison, Director of Science and Agriculture in British Guiana, whose recent death is so deplored. No data as yet available as to the conduct of this cane in Porto Rico.

Erect, at length recumbent, splendid vigor, excellent stooler. Stalks long, good girth, green to yellow with abundant, narrow, discolored, vertical striations, some bloom. Internodes medium length, decided tendency to split, cylindrical but enlarged at base opposite bud, slightly staggered, no furrow. Nodes constricted, oblique; growth ring very broad, 4–6 mms, elevated, oblique, reddish brown; root band narrow, oblique, covered with reddish wax deposit; rudimentary roots very small, few and scattered, only one to two in rows, inconspicuous; leaf scar glabrate, broad in front and appressed behind; glaucous band broad, constricted and rather inconspicuous. Buds medium size, 7–9 mms, plump, suborbicular, reaching growth ring, germination subapical, margins wide, flat, lannate, extending to base, purple, short apical tufts and light basal placs. Leaf sheaths with sparse dorsal ciliation of short tawny hairs, side glabrate, slightly tinted within and without, glaucous, throat broad, lannated, with short appressed hairs, few long and straggling hairs at margins, tendency to split, collar wide and reaching midrib, glaucous, ligule narrow, 2–4 mms, at sides, becoming broader and concave at center, no ligular process Leaf blades spreading with declining tips, broad, 7–9 cms., dark green, margins uniformly serrated, very scant basal ciliation

D 695.

Another of the promising varieties received in December, 1924, from the originater of this variety, Sir John B. Harrison, Director of Science and Agriculture in British Guiana, whose recent death is so deplored No data as yet available as to the conduct of this cane in Porto Rico.

Recumbent, fair vigor, moderate stooler. Stalks long and slender to medium girth, green to yellow, slight striations, heavy bloom. Internodes medium length, cylindrical, but slightly enlarged at base

opposite bud, somewhat staggered, decided tendency to split, furrow traces to none. Nodes nearly even, oblique; growth ring narrow, except at outer curve of bends, where it broadens notably, elevated, reddish brown; root band narrow, oblique, covered with dark waxy deposit; rudimentary roots very few and scattered, small, 2–3 in rows, brownish; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band broad, constricted and inconspicuous. Buds small to medium size, 5–7 mms., ovate not exceeding growth ring, germination apical, margins narrow, flat, glabrate, on upper half only, shouldering at sides, purple, no apical tufts nor basal placs. Leaf sheaths lannated at back, sides glabrate, inner base slightly tinted, glaucous; throat medium width, dark, lannate with short coarse, appressed hairs, tendency to split; collar broad, reaching midrib, glaucous, brownish; ligule narrow, 2–4 mms., at sides, broadening to 4–6 mms., at center, where it is slightly concave, ligular process short and broad, on one side only. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, serrated at margins, very scant basal ciliation.

D–848.

Introduced from Antigua by Mr. Sewall in 1911. It does not seem to have been planted elsewhere.

Not seen.

D–1111

Introduced from Antigua by Mr. Sewall in 1911. It is mentioned in the Fajardo monthly reports for 1914. This cane seems to have attracted no attention excepting on one farm near Naguabo, and on another near Río Grande, where it is being planted on a large scale. In both cases it was on hill land and doing much better than Rayada or any other kind planted there. It is a clean-growing, upright, brownish cane. Seed brought to this Station in January, 1921. It made a good germination.

D-1135. See Plate III, opposite page 191.

Introduced from the Hawaiian Islands via Washington, by this Station in January 1921. Its good germination was most notable from the first and it has been rapidly multiplied for tonnage and substation experiments, as well as for seed distribution. Considerable quantities have been sent to the Island of Vieques, where it has done remarkably well under the distressing conditions for cane growth on that island. Fair amounts, too, have been supplied to the Bayaney, "Los Caños" and Plazuela properties of the Giorgetti company, all located in districts where mosaic disease has become

most firmly established and where rogueing is a commercial impracticability. It has done particularly well on the hilly Bayaney property, and on the rich *vegas* of "Los Caños" has also shown up well, but it is not apparently adapted to the *semi-poyales* at Plazuela and its cultivation will be discontinued there. At the Hatillo Fruit Farm, on shaly red hillsides, General Manager W. C. Dreier, who has furnished us with so many useful observations on varieties under those conditions, has obtained most satisfactory results where most other canes, outside of the North Indian or P.O.J. types, do not grow at all. It is highly resistant to Mosaic Disease, though perhaps not so much so as in the cases of P.O.J. 36 and 213. Tried out in the Argentine a decade ago by the writer, it came next to the above P.O.J. canes in general promise and proved to be a most excellent ratooner for many years.

This cane was sent by the Department of Agriculture and Science of British Guiana, where it was considered a complete failure under Demerara conditions, to the Australian Sugar Refining Co. at Sydney, Autralia, along with some fifty to sixty other varieties, some thirty years ago, and has rapidly become the most prominent variety in Queensland. In 1920 Easterby reported it to be more resistant there to grubs than either Badila or Goru and that it was coming rapidly into prominence in the Cairns district, 50 per cent of the cane then being planted at Mossman being reported as of this variety. The Entomologist of the Bureau of Sugar Experiment Stations, Mr. J. F. Illingworth, in 1920 and in several earlier reports called attention to the deep-rooting habit of this cane and to its comparative resistance to the attacks of grubs:

"In making further study the past season, I find much to recommend D-1135 as a cane for the volcanic, red, grub infested soils. A remarkable instance is a field of three varieties planted for experiment in an area invariably devastated by grubs at Maringa. D-1135 has Badila on one side and Goru on the other. The grubs have killed the Badila and badly injured the Goru while the 1135 is hurt but little, standing out in marked contrast between the two devastated plots with its dark-green color and superior height."

Illingworth also reports success in grub control with arsenic applied in drills with seed at the rate of 60 to 100 pounds per acre.

In Hawaii, too, this variety has become very popular of late years and is rapidly replacing the famous "Tip" canes on the higher and poorer lands. In the Bulletin of the the Hawaiian Sugar Planters' Experiment Station, Vol. III, Pt. 1, p. 10, the statement is made that "This cane is so resistant to mosaic that practically it may be

called immune", but Cross in 1921 stated that "In Tucumán it has not demonstrated a very marked resistance, although, amongst the non-immune varieties that we have, it is certainly one of the most resistant. . . It has the advantage over the P.O.J. 36 and 213 . . . of not suffering from rapid inversion immediately after cutting."

Erect, splendid vigor, fine germinator, arrows prolifically. Stalks long and rather slender, reddish purple, some bloom. Internodes medium length, cylindrical, slightly staggered, furrow slight to none. Nodes even; growth ring broad and even, parallel, yellowish green; root band wide, oblique, yellow; rudimentary roots fairly abundant, conspicuous, 3–5 in rows, purple; leaf scar glabrate, appressed behind; glaucous band narrow, slightly constricted and poorly defined. Buds small, 8 × 10 mm., scarcely exceeding growth ring, orbiculars, germination subdorsal; margins broad, flat, glabrate, purplish, distinctly shouldered above, very light basal places. Leaf sheath with heavy dorsal vestiture of long tawny hairs, sides glabrate, glaucous, purple, inner base slightly tinted with purple; throat narrow, inconspicuous glabrate except for long marginal tufts; collar narrow, reaching midrib, glaucous; ligule medium width, 3–5 mm., nearly even, ligular process none. Leaf blades erect, narrow, 4–6 cm., dark green, margins minutely and uniformly serrulated.

In an experiment with the sixteen most promising varieties of cane at the Station, planted in October, 1924, D–1135 was fifteen days ahead of all others in germination and in germination counts made in this plot until the cane closed, it consistently held first place by a wide margin. Grown for seed distribution on a poor, red clay hillside at the Station in extension of about an acre and cut at from eight to twelve months, this variety has consistently yielded around thrity-five tons per acre both as plant and stubble. It was reported as a disappointment at Central Aguirre, but Mr. R. L. Page, in charge of cultivation at Guánica Centrale, wrote us in regard to D–1135 on 20th June, 1925:

"We have a small field planted in Santa Rita on hillside land which looks very promising. We have some of this variety in Hormigueros and Añasco district."

From San Antonio de los Baños, in Havana Province, Cuba, Mr. Richardson Kuntz wrote us about the same time:

"Of Demerara canes, we have here 1135, 117, 109, 216, 99, 74 and 625, and of all these the D–1135 is the best germinated and most prolific, but it suffers considerably from drought."

The following analyses have been made:

Location	Date	Age	Mill	Tons Cane p a	Brix	Sucr	Purity	Tons Sugar p a
Cent Aguirre	I 23 23	13 mo	Hand		18 10	15 46	85 80	
Cent Aguirre	II 22 23	14 mo	Hand		18 20	16 17	83 40	
Cent Aguirre	III 19 23	15 mo	Hand		19 50	16 62	83 20	
Ins Station .	May 23	Rat 12 mo	Hand		19 70	18 05	91 62	
Cristalina	May 23	Rat 12 mo	Hand		19 90	18 84	94 67	
Ins Station	May 25	12 mo	Cent	40 00	16 80	14 23	84 70	4 15
Ins Station	II 9 25	16 mo	Cent	55 76	14 90	12 53	84 90	5 08
B H 10 (12)	II 9 25	16 mo	Cent	54 81	17 43	15 00	86 06	6 05
Hatillo I t.	V 14 25	14 mo	Hand		18 10	16 20	91 01	
B H 10 (12)	V 14 25	14 mo	Hand		18 85	16 80	89 12	
B H 10 (12)	V 14 25	14 mo	Cent	21 10		15 81	87 50	2 82
B H 10 (12)	V 14 25	14 mo	Cent	21 80		17 90	89 86	2 92

In the Station tonnage experiment in comparison with BH-10(12), figures for which are given at the foot of the above table, these canes were all planted on good *vega* land, on which it is not likely that the D-1135 can compete with BH-10(12), although it stood fourth out of sixteen varieties in this experiment in production of sugar per acre It is under unfavorable conditions, both climatic and from the disease standpoint, that this cane shows up to the best advantage and results of some of the substation tests under such conditions will give us much more substantial data as to the comparative value of this promising variety

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EASTERBY—Queensland Journal, Sept., 1920, p. 143.
ILLINGWORTH, J. F—Report of the Entomologist. *Ibid,* p. 148.

D-1135 Striped. Mr Luis Serrano, Assistant Agronomist of the Station has found and bred true to type a striped sport of D-1135, which, in everything but color, seems identical to the usual type. Comparative experiments with this sport are planned

D-1170

A cane grown under this number was seen by Mr. Earle at Central Coloso in August, 1919 Not seen elsewhere and we have no knowledge of its origin

D-4395

A cane under this number was noted by Cowgill, July, 1913, at Dolores, Río Grande We have no other knowledge of this kind

Diamond-185.

The Diamond Seedlings were produced at a plantation of that name in Demerara. This one was imported by this Station from Barbados in 1911. Its record was nearly equal to Cristalina, both in tonnage and sucrose.

Not seen.

REFERENCES

BOVELL, J. R., & D'ALBUQUERQUE, J. P.—Seedlings Canes and Manurial Exeperiments for the Season 1909–11. Local Dept. of Agr., Barbados.

Idem.—Ibid., Season 1911–13.

Diard.

Imported by Dr. Grivot Grand Court prior to 1879. Mentioned by both Stahl and López Tuero. As nearly as can be determined this = Cristalina. The striped form mentioned by López Tuero = Rayada.

Egyptian.

See Java 105–P.O.J. and Plate XIII, opposite page 209.

*** Elephant.**

(= Gigante.) Introduced from Trinidad by Dr. Stahl prior to 1879. Only seen in the experimental plots at Central Fajardo.

Erect, late, long-continued growth, no arrows. Stalk very brittle medium tall, very stout, 5 cm. or more, dull purple, very heavy bloom. Internodes short, 5 to 8 cm., nearly straight, cylindrical or the shorter ones barrel shape, furrow none. Nodes scarcely constricted, nearly perpendicular; growth ring narrow, concolorous, a little sunken, being usually the narrowest part of the stalk; root band about 10 mm., concolorous; rudimentary roots obscure, in about 4 rows; leaf scar glabrous, short, appressed behind; glaucous band obscured by the bloom of the internode. Buds hemispheric, about 11 mm. in diameter, margin abruptly widened at the middle where it forms an obtuse sterile apex fully 3 mm. long, forming a very conspicuous character, exceeding growth ring only by this sterile apex, germination dorsal, glabrate except for placs of short appressed hairs at base. Leaf sheaths with a heavy vestiture of stiff assurgent hairs usually splitting down the back, strongly pouched below the bud, green or somewhat tinted, heavily glaucous, stained purple within; throat very wide, glaucous, usually with transverse checks, glabrate except for scattered tufts of hairs at margins, collar very wide, conspicuous, reaching the midrib, heavily glaucous, not lannate; ligule short, 2 to 3 mm., even; ligular processes none. Leaf blades long, spreading, somewhat revolute, very wide, 7½ to 9 cm., gray-green, minutely serrulate, the base slightly ciliate.

It is said to be low in sucrose. Probably of no commercial value, but of considerable historic interest. It represents a rather distinct type.

Guingham.

López Tucro page 9. Here this name seems to = Rayada. There is no evidence of the occurrence on the Island of the true Guingham = Striped Tanna.

Hawaii-109. See Plate III, opposite page 191.

Seedling of Lahaina. Male parent probably Rose Bamboo. This now world-famous cane, which holds all records for production of sugar per acre and which in Hawaii's 1925 crop, occupied 30 per cent of the cane area of those islands, came to us from Hawaii in early 1924 with the halo surrounding its tremendous yields in that progressive country, some of them equalling in sugar produced per acre the quantity of cane produced per acre in many sugar sections. It has previously and since been surreptitiously introduced to the Island by enthusiasts who have read of its Hawaiian behavior.

Erect, good vigor, fine stooler, arrows freely. Stalks long, good girth, greenish pink to dark purple becoming reddish brown on maturity, heavy deposit of grayish wax becoming dark with age. Internodes medium to long, somewhat staggered, cylindrical, slightly appressed at sides and enlarged at base opposite bud; furrow traces to none. Nodes oblique even, or slightly elevated; growth ring broad, nearly even, green to concolorous; root band wide, oblique, light green to concolorous; rudimentary roots large, conspicuous, numerous, 3–4 in rows, purplish to concolorous; leaf scar glabrate and appressed behind; glaucous band broad, nearly even, inconspicuous. Buds medium size, reaching growth ring, plump, green to red and purple, orbicular, germination subdorsal, margins narrow, flat, glabrate, purple, concave at center, but sometimes acute, wider at upper sides, gradually narrowing and ending at middle point of bud, short apical tuft, scanty lannation along fibro-vascular bundles, light basal placs. Leaf sheaths with abundant dorsal lannation, sides glabrate, greenish purple; inner base slightly tinted with purple; throat broad, covered with short appressed hairs, dark and well defined, tendency to split; collar broad, reaching midrib, glaucous; ligule medium width, nearly even; ligular process on one side only, short and stubby, deciduous. Leaf blades erect with declining tips, medium width, dark green, margins minutely and uniformly serrulated to base, long and abundant basal ciliation.

The writer has constantly taken the position with inquiring planters that the enormous yields of this variety on the best lands of Hawaii—and it is planted only under the most favorable conditions of both soil and climate—with the unheard-of (in Porto Rico) quan-

tities of fertilizer and water applied, should not in the least be taken as a criterion of the value of this variety under the very diversified conditions of the "Isle of Enchantment", but such advise has not prevented the purchase of small quantities of this seed—or what was supposed to be this seed—at fabulous prices from anyone who claimed to have any of it. Results both at the Station and out on the Island in general, even under the most favorable conditions for this type of cane on the South Coast, have fully borne out the always sane practice of never trying to apply the results of work in one country to the distinct conditions of another without preliminary trials.

Planted on both *vega* and hill lands at the Station, in the former case in comparison with BH-10(12) and in the latter with *D-109* and *1135*, H-109 has never equalled its checks in general appearance, disease resistance or yield, while on the South Coast, where conditions are the nearest possible to adequate for this variety, in all comparative plantings of this variety with BH-10(12), the latter has always turned out definitely superior to the H-109. This applies to plantings on a fair-sized scale seen at Santa Rita, Guayanilla, Fortuna and Aguirre. In a tonnage experiment planted out in the fall of 1925 at the Station, the H-109 is showing up very poorly and in various points on the Island it has proven to be highly susceptible to *Helminthosporium* leaf spot, from which it suffers more seriously than any other varieties in Hawaii, as well as to mosaic disease and gumming.* Mr. W. C. Jennings, Associate Agriculturist of the Hawaiian Sugar Planters' Experiment Station, after a trip over the Island with the writer to all points where H—109 was being grown to any appreciable extent in January, 1925, expressed the opinion that there is no future for this variety in Porto Rico.

The author tried out H-109 in Argentina many years ago, before it had become so famous, and it turned out an absolute failure under those subtropical conditions. Under date of 28th January, 1925, Mr. F. S. Earle wrote us from Cuba:

> "H-109, while doing fairly well on red land, is a complete failure on Calvino's plots on thin, black, coco, subsoil land. It is shot to pieces by chlorosis."

while Mr. P. Richardson Kuntz said in a letter to the writer on 30th May, 1925:

> "The H-109 does not prosper here (Province of Havana). It suffered severely from the drought. Don't think she'll ever amount to anything in Cuba."

* The H-109 has proven to be very susceptible to gumming disease and is being rapidly eliminated throughout the Island.—C. F. CHARDÓN (July 1927)

REFERENCES

ROSENFELD, A. H.—Cañas de Semillero de Hawaii. Revista Industrial y Agrícola de Tucumán (Argentina), Año IV, 3, p. 96. Ag., 1913.

VERRET, J. A.—An Acreage Census of Cane Varieties for the Crops of 1923, 1924, 1925. Hawaiian Sug. Plant. Expt. Sta., Circ. 41. 1924.

Jamaica-72. See Plate III, opposite page 191.

Sent from Jamaica by Director R. Menéndez Ramos, of the Insular Experiment Station of Porto Rico, while visiting that island, in July, 1924. The seed arrived in bad condition and 80 per cent failed to germinate and we have had to rogue so constantly on account of severe mosaic infection, in a plat where other varieties showed no signs of the disease, that we have been unable to multiply it to sufficient quantity to start tonnage experiments. Hardly seems promising for Porto Rico.

Erect, fair vigor. Stalks long, medium girth, green, light bloom, no flush, discolored striations and sometimes spots. Internodes long, appressed, slightly staggered, furrow none. Nodes slightly constricted, oblique; growing ring medium width and slightly elevated, brownish red changing to concolorous; root band wide, oblique, concolorous, light wax covering; rudimentary roots conspicuous, crowded, 3–5 in rows, brown; leaf scar glabrate, appressed behind; glaucous band slightly constricted, narrow and only fairly well defined. Buds medium size, 9–11 mm., never reaching growth ring, orbicular germination dorsal, margins narrow and flat, lannate along fibro-vascular bundles, abruptly shouldered above, purple, heavy basal placs. Leaf sheaths with scanty dorsal vestiture of tawny hairs, sides glabrate, glaucous, green, inner base slightly stained with purple; throat broad and well defined, lannate with closely appressed short hairs; collar medium width, reaching midrib, glaucous; ligule broad, 4–6 mm., nearly even, ligular process none. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, margins minutely and uniformly serrulated, sparsely ciliate at base.

THE JAVA SEEDLING CANES

The best known series of Java seedlings are the famous P.O.J. canes bred by Kobus and his successors, although the most widely cultivated Java seedling in its country of origin today is the E.K.-28. Kassoer is also included amongst the Java seedlings described in the following pages, also one representative of the Tjepering series.

E.K.–28. See Plate III, opposite page 191.

Produced by E. Karthaus by crossing P.O.J. 100 as mother and E.K. 2 as father. Brought to the Station from the Federal Station at Mayagüez in December, 1924, through the courtesy of Plant Breeder Davis of that staff. In tonnage experiments at the Station on low, poorly drained *vega* soil, it has not shown up too well, although it is of fair appearance and promises good tonnage. At the "Los Caños" substation it does not look especially well on very good vega land, but at Central Constancia in 1925 a small field of an unknown variety, which looked superior to any cane on the estate, was identified by the writer as E.K.–28 and is being rapidly extended by Mr. Manuel del Valle there. A few stools seen at the Mayagüez Station certainly had attained most excellent development, although some seed obtained from those same stools failed to do at all well for Mr. Dreier on rather inferior shaly hill land at the Hatillo Fruit farm near the Station. Unfortunately, this excellent cane is decidedly susceptible to gumming.

Mr. J. van Haarevcld in 1924 stated that E.K–28 occupied 43.75 per cent of the total cane area of Java, a percentage which it seems to have maintained since.

Erect, fine vigor, good stooler, flowers prolifically. Stalks long, yellow base color, becoming dark amber, with reddish brown flush on exposure to sun, short, dash-like, discolored checking. Internodes long, cylindrical, slightly enlarged at base, not staggered; furrow pronounced, flat and wide, becoming narrower and deeper in older internodes. Nodes even, parallel; growth ring medium width, prominent, bright green on bud sides and bright red behind, later changing to uniform purple brown; root-band broad, distinct, parallel, at first white, changing through light green to brownish green; rudimentary roots few and scattered, conspicuous, 3–4 in rows, light purple to reddish brown; leaf scar glabrate, appressed behind; glaucous band conspicuous and broad. Buds at first large, flat and decidedly lanceolate, changing with age to smaller but plumper, orbicular-ovate type, 8 × 10 mm., when young exceeding growth ring by one-third to one-half, later scarcely exceeding growth ring, germination subapical, margins narrow, flat, sparsely lannated, very pronounced apical tufts of long, coarse, white hairs, no basal placs: Leaf sheaths with scanty dorsal vestiture of short deciduous white hairs, glaucous, heavily splotched with purple; inner base lightly tinted; throat broad and conspicuous, lannate, with long deciduous hairs at margins; collar wide, reaching midrib, glaucous; ligule narrow at margins, abruptly widening and becoming peaked at center,

fimbriate, with characteristic tip; ligular process, small, broad, blunt, inconspicuous and on one side only. Leaf blades spreading with decidedly declining tips, very broad, 10–12 cms., dark green with very broad white midrib, very minutely and uniformly serrulated, sparse basal ciliation on young leaves only.

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HAAREVELD, J. VAN.—Java Archief, Med. No. 5, pp. 169–250.

Kassoer. See Plate V, opposite page 239.

This is a cross between the wild *Saccharum spontaneum* and Cheribón which, on account of its notable resistance to Sereh and mosaic disease, as well as its remarkable development under even the most adverse conditions, is being widely used in Java and by Brandes in Florida for the production of crosses from known parents. It has never been accused of having any sugar content anywhere, although one factory analysis made at Central Vannina the 26th May, 1926, of nineteen month *gran cultura,* did show a *Brix* of 15.53, a sucrose content of 11.46 and a purity of 74.70—probably the highest recorded analysis for this variety. It was obtained in May, 1924, from Dr. E. W. Brandes, Senior Pathologist in Charge of the Sugar Plant Investigations of the U. S. Bureau of Plant Industry.

Erect, splendid vigor, stools prolifically, light arrower. Stalks long, slender to medium diameter, red to purple, extremely heavy and uniform bloom. Internodes very long, 12–14 inches, cylindrical but enlarged at base, not staggered, no furrow. Nodes constricted, almost parallel; growth ring prominent, conspicuous, green, through yellow and red to concolorous; root band very wide and slightly constricted, nearly parallel, green then red to concolorous; rudimentary roots rather few and scattered, inconspicuous, 4–5 in rows, purple to concolorous; leaf scar glabrate, appressed behind; glaucous band inconspicuous and nearly even. Buds varying from small to medium, not reaching growing ring, oval, germination subapical, margins on upper half only, flat, sparsely lannated, no basal placs. Leaf sheaths with scanty dorsal vestitures, side glabrate, green, slightly glaucous, inner base slightly tinted with purple; throat wide and distinct, covered with abundant vestiture of long coarse hairs; collar wide and rather conspicuous, reaching midrib glaucous; ligule medium width, 3–5 mm., slightly fimbriate; ligular process very long, up to 7 cms., on young canes, deciduous. Leaf blades spreading with declining tips, narrow, 6–8 cms., dark green, minutely and uniformly serrulated and ciliated except at base.

The well-known Tjepering series of seedlings in Java are crosses of Kassoer and Cheribón canes.

At four months of age on poor, red, clay hillside land at the Station this fast-growing cane had already developed six to seven long joints on the average. One such stalk, having eight well-formed internodes was given Mr. Dreier to plant at the Hatillo Fruit Farm in order to see if the variety would reproduce itself at this early age. Mr. Dreier planted each one-eye seed piece in a distinct hole and obtained just eight fine stools of this variety, using eight similar seed pieces of Cayanna for a check on the germination. In nine days the Kassoer was 100 per cent germinated, while the Cayana showed just one sprouted eye. Seven days later Cayana showed just two sprouted eyes and only three two days after that. It was twenty-five days before Cayana showed 100 per cent germination.

REFERENCES

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ROSENFELD, ARTHUR H.—Informe Anual del Tecnólogo Especial para Cañas. Informe Anual de la Est. Exptl. Insular de Puerto Rico, Año Fiscal 1923–24, pp. 69–76.

THE P.O.J. SEEDLINGS

Very shortly after the recognition of the fertility of true cane seed in 1888–89 by Harrison and Bovell in Barbados and Soltvedel in Java, working completely independently, extensive breeding of varieties from known parents was commenced by Kobus and Wakker at the Proefstation Oost Java (hence the initials P.O.J.), or East Java Experiment Station. Kobus and Wakker employed the Indian cane Chunnee (one of the Saretha class), a variety of enormous vigor and high resistance to disease under unfavorable conditions, as the male parent in these crosses, and the Black Cheribón and Striped Preanger, corresponding to our Morada and Rayada, as the female. This combination was used with the object of obtaining a "hybrid" with the sereh-resistant qualities of Chunnee and the very desirable cultural and manufacturing qualities of the female parents, then in common cultivation in Java. In later year Kassoer, E.K.–28 and other canes have been substituted as parents, but the majority of these canes described in the following pages are of the Chunnee X Cheribón strain, as will be seen from the notes on parentage thereto appended, and partake of the characteristics of the greater number of the varieties produced by these crosses, *i. e.*, they all have long, narrow leaves, long thin joints, extremely hard rind and a modified central

fistula. In referring to the parentage the male parent is given first in each case. Colors mentioned refer only to that of the mature cane.

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ROSENFELD, ARTHUR H.—Las Cañas P.O.J. de Java. Inf. Ann. de la Est. Expt. Insular de Puerto Rico, 1923–24, pp. 74–5.

Java 36–P.O.J. See Plate XXIII, opposite page 209.

A cross of Chunnee with Striped Preanger (By an error first recorded by Earle as Java–56.)

Imported from the Argentine in 1917 by the Mayagüez Station. Sent out by them to various parts of western Porto Rico. Included in the Santa Rita immunity experiment, where it took the highest rank in resistance to both root disease and mosaic. It is a strong ratooner and gives heavy tonnage, but hardly equal to Uba in this respect. In the Argentine it matures earlier than Uba and is now one of their two chief commercial canes.

Erect or at length somewhat declined, very vigorous, a strong stooler, arrows frequently Stalks long, slender, usually less than 2½ cm., brownish purple, little bloom. Internodes long straight, cylindrical, furrow scarcely evident. Nodes broad, prominent, not constricted; growth ring narrow, conspicuous, greenish; root band broad; rudimentary roots inconspicuous; purplish, in about 3 rows; leaf scar glabrous; glaucous band conspicuous, not constricted. Buds large, broader than long margin broad, uniform. Leaf sheaths glabrate, purplish, throat minutely lanate and with a scanty vestiture of long hairs; collar narrow, inconspicuous, not reaching the midrib; ligule abruptly broadest at the center (as in Uba); ligular processes none. Leaf blades spreading, narrow, long acuminate, weakly serrulate to the base.

The following yields and analyses have been recorded from around the Island:

Variety	Location	Age	Tons cane per acre	Brix	Sucrose	Purity
P O J 36	Añasco	G C	45 00			
P O J 36	Añasco	1st Rat	18 90			
B H 10 (12)	Añasco	2nd Rat	35 50			
P O J 36	Los Caños	G C	41 85			
Rayada	Los Caños	G C	18 10			
P O J 36	Los Caños	G C			14 37	85 25
P O J 36	Los Caños	G C		16 84	14 98	87 51
Rayada	Los Caños	G C		17 12	12 15	81 90
P O J 36	Rincón	G C		14 84	16 36	85 06

These figures are taken from the writer's work on "The Java P.O J Canes in Tucumán and Porto Rico", to which the reader is referred for data on dates of analyses, general conduct, etc.

PLATE XXIII

P. O. J. 36 P. O. J. 213 P. O. J. 105

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P.O.J.-36(M). See Plate III, opposite page 191.

This is a sport of P.O.J.-36, originated by Versteegh at the Sugar Experiment Station at the town of Shinka. The "M" stands for Mingka, which means "Stripe"; distinguished from P.O.J.-36 by small stripes in the immature internodes. It was imported by the S. P. I. of the U. S. Bureau of Plant Industry from Formosa. Through Dr. E. W. Brandes, Senior Pathologist in Charge of the Office of Sugar Plant Investigations of that Bureau, we obtained, a cutting of this cane in May, 1924. From the first, even though planted on extremely poor red clay hill soil, it made remarkably good development and when planted out for extension in *vega* land under extremely moist conditions, it distinguished itself for its vigor, even in comparison with P.O.J.-36 and *Kassoer*.

Erect, fine vigor. Stalks long and slender (about diameter of P.O.J.-36), green base, overlaid with rose to purple, heavy bloom. Internodes long, cylindrical, slightly staggered, furrows slight to none. Nodes wide and prominent, oblique, growth ring medium width, even with internodes, green changing to light reddish brown; root band wide, well defined, elevated, concolorous, with waxy covering; rudimentary roots small, inconspicuous, very few and scattered, 2-3 in rows, purplish to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind, glaucous band fairly conspicuous, bud not well defined, almost even Buds medium size, 8 × 10 mm., plump, scarcely exceeding growth ring, orbicular, germination subapical, margins very narrow and on upper half only, with abundant vestiture of fine tawny hairs, distinct apical tufts of short hairs, light basal place. Leaf sheaths glabrate, slightly glaucous, somewhat tinted, inner base lightly stained with purple; throat broad, lannate with long marginal tufts; collar wide and inconspicuous, reaching midrib, glaucous; ligule wide 4-6 mm., nearly even; ligular process short and stubby, on one side only, apparently deciduous. Leaf blades erect with declining tips, narrow, 4-6 cms., dark green, upper two-thirds minutely serrulated, no basal ciliation.

Mr. R. L. Page, Manager of Cultivation for Russell & Co., at Guánica Centrale, wrote the author under date of 20th June, 1925:

"I secured a few of the seeds at the same time that I got the P.O.J.-36 (in April) and I believe that this variety is making a better growth."

At the substations at Bayaney, under typical hill conditions, at "Los Caños", on good *vega* land, and at the Hatillo Fruit Co. Farm on poor red clay hillside, it is doing extremely well, as well as in the tonnage experiment on poor *vega* land at the Station. Seems a very promising variety.

P.O.J.–100.

According to Cowgill's notes, such a cane was in the Fajardo collections in 1914. It is not to be found there now. It probably came in the direct importation mentioned by Mr. May.

This was about the best looking of the earlier P.O.J. seedlings, being an ambar-colored cane of very good girth. As plant cane in our early experiments with these varieties in Tucumán in 1911 it gave very promising results and one plantation in Argentina extended it very rapidly for a couple of years. It proved to be a very inferior ratooner to the P.O.J. 36, 105, 213, 228 and 234, however, and also suffered to a certain extent from mosaic disease in Tucumán and from sereh in Java, in both of which countries its cultivation was ultimately abandoned.

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*** Java 105–P.O.J.** See Plate XXIII, opposite page 209.

(Also known as Egyptian cane.) Parents Chunnee X Striped Preanger. Probably included* in the importation from Egypt mentioned by Mr. May (see letter). This cane was first seen by the writer in the Argentine some fifteen years ago and Mr. Earle reports seeing it first in the fall of 1918 at Central Córsica in western Porto Rico. It was growing vigorously, notwithstanding a complete infection with mosaic, and presented a striking contrast to the Rayada and other kinds which were all seriously injured by mosaic. It was called "Egyptian cane" and seed was said to have come from the Mayagüez Station some five years before. Later the same cane was seen in the outskirts of Mayagüez, where it was being called "Pesante cane" after the owner of the farm where it occurred. This cane for a while attracted much attention and was widely planted in the extreme western districts. From the full description published by Fawcett (Rev. Indust. y Agric. de Tucumán, 9: 142, 1919) it seems quite certain that this is 105–P.O.J. It came to the Argentine from Egypt and is known as *Ambar de Egipto*. A note in our files

shows that on October 24, 1914, six varieties of Egyptian canes were received from the Mayagüez Station, but there is no data as to what became of them. This one can not be traced among them.

Erect, vigorous, strong stooler, arrows freely. Stalks tall, slender, usually, less than 2½ cp., brownish, very heavy bloom. Internodes long cylindrical or a little compressed, furrow evident. Nodes prominent, enlarged; growth ring broad, even, yellowish; root band broad; rudimentary roots inconspicuous, purplish, in about 3 rows; equal on all sides, not compressed behind, the widest part of stalk; glaucous band indistinct, obscured by the bloom of the internode. Buds large, triangular, margin wide, strongly shouldered (as in Cristalina), nearly glabrous. Leaf sheaths glabrous, tinted; throat slightly lannate, with scanty tufts of hairs on the margins; collar glaucous; ligule broad, broadest at center; ligular processes none. Leaf blades suberect but tips declined, long, narrow, bright green, scarcely serrulate, nearly even.

Like the other P.O.J. hybrids this cane is very resistant to both root disease and mosaic. It is in no sense immune to the latter disease like the Uba, since every stalk seen of it is infected, but it does not stop its growth. It was strongly recommended by Earle for the heavily infected western districts where it was extended very rapidly for a few years, but it seems evident now that P.O.J.–36 is superior to it. In the Argentine it is considered to be late in maturing. Here its sucrose content is not entirely satisfactory either, both P.O.J. 36 and 213 generally surpassing it in this respect. An analysis of 14-month arrowed plant cane brought by Mr. Earle from Rincón, December 1, 1920, showed: extr., 68.4; brix, 16.50; sucrose, 13.11; R. S. 2.72; purity, 79.45; fiber, 13.27. This is not bad, compared with other canes at this early date, but the large amount of reducing sugars and the low purity show that the cane was still very green. A few other results over the Island follow:

Variety	Location	Age	Tns. cane per acre	Brix	Sucrose	Purity	Date
P. O. J. 105	Mayagüez .. .	17 months	42.00	....	....	....	1924
P. O. J. 36	Mayaguez	17 months	52 18	. ...	....	....	1924
P. O. J. 105	Añasco.	1st Rat ...	85 00	....	....	.. ..	1924
P. O. J. 105	Añasco	1st Rat....	80 00	....	....	....	1924
B H 10(12) ..	Añasco.	3rd Rat....	85 00	....	....	....	1924
P. O. J. 105	"Los Caños"....	G. C	40 93	....	....	. ...	1924
Rayada	"Los Caños"....	G. C......	14 15	. . ..	....	.. ..	1924
P. O. J. 105	"Los Caños"....	G C......	....	15.08	12 44	82 87	1-23-24
P. O. J. 36	"Los Caños"....	G. C......	....	17.12	14 96	87 51	1-23-24
Rayada....	"Los Caños" ...	G. C	....	14 84	12 15	81 90	1-23-24
P. O. J. 105	"Los Caños"....	G. C	....	15.81	12 48	78 60	1-24-24
P. O. J. 36	"Los Caños"....	G. C......	....	16.84	14.87	85 25	1-24-24
P. O. J. 105	Rincón.........	G. C......	....	. ...	15 06	85 28	Jan., 24
P. O. J. 36	Rincón	G. C......	....	....	16.86	85.06	Jan., 24
P. O. J. 234.......	Rincón..	G. C......	... .	... .	16.08	85 27	Jan., 24
P. O. J. 105	Cambalache....	G. C......	....	18.00	14 87	82 07	4-3-24
P. O. J. 213.......	Cambalache....	G. C......	....	16 65	14.33	86 07	4-3-24

These small series of data on cultural yields and chemical analyses under comparative Porto Rican conditions show us that the P.O.J.–105 has behaved here in a surprisingly similar manner to its conduct in Tucumán, Argentina, in relation to the P.O.J.–36 and 213, which are the canes with which it should logically be compared. In Tucumán we found that the P.O.J.–36 and 213 far outdistanced the 105 in yield of cane and sugar per acre under comparable conditions, as well as in tolerance of their 100-per-cent infection with mosaic disease and to various root troubles. As an early maturer P.O.J.–234 was superior to all others in Argentina, but its cultural yield was never so high as the others and it cannot compare with either of the others in long ratooning qualities. The P.O.J.–105, however, certainly stood at the bottom of the list of these four canes in Tucumán in point of cultural and factory yield, years of ratooning, early maturity and resistance to mosaic and other diseases. A glance at the Mayagüez results shows that P.O.J.–36 outdistanced the "Egyptian" by around ten tons of cane per acre, while at Añasco B.H.–10(12) as third ratoons gave superior results to P.O.J.–105 as first. While actual comparative tonnage data is lacking from "Los Caños", where there are large areas of both canes, personal inspection by the writer has shown the P.O.J.–36 to be far superior in general appearance in the field, in tonnage of both cane and sugar per acre, in length of ratooning, in earliness of maturity and in tolerance of mosaic. The manager, Mr. Antonio Fraticelli, is thoroughly in accord with the author in this. The Rincón analyses show over a point less sugar in the juice of P.O.J –105 in January than in that of the 36, while the "Los Caños" analyses show the P.O.J.–36 about two points in sugar and some five points in purity ahead of the 105. Finally, the Cambalache data show a superior purity by some 3½ points for P.O.J.–213 over P.O.J.–105. Why, then, is the so-called "Egyptian" cane so much more extensively cultivated in Porto Rico than any of the other three varieties here discussed in camparison? The answer is hard indeed to find except upon the grounds that the seed of the former was more easily obtainable when interest was first awakened in this class of cane at the time of the severe outbreak of mosaic disease on the West Coast and planters have learned to know this variety while seldom seeing the other—and manifestly superior—types. The author would strongly advise the substitution of this cane, wherever it is being grown, by the P.O.J.–36, pending the obtaining of more definite results in our substations from several others of the more promising and newer P.O.J. seedlings such as the 826, 979, 2714 and 2725.

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Java 213-P.O.J. See Plate XXIII, opposite page 209.

Cross of Chunnee with Cheribón (Black). Imported from the Argentine by this Station in January, 1921. Is doing very well indeed on a field scale at Bayaney and "Los Caños". This is one of the two canes which saved the Argentine sugar industry from complete destruction in the last decade and is being used as a parent at the Coimbatore Experiment Station in India. It is highly tolerant of mosaic and root disease and quite resistant to drought, although it is rather a slow germinator It matures quite early in the season.

Recumbent. Stalk dark purple to wine color. Rind fissures in older joints, no growth fissures. Wax layer at first plain and thick, diminishing with age; glaucous band sharply defined. Internodes long, cylindrical, slightly concave on eye side and convex on opposite, slightly zigzag, ¾th to one inch in diameter. Pith smooth, often with a fistula, very hard rind. Growth ring horizontal, even, wide, 4–6 mms., yellow splashed with red. Root band cylindrical, more or less c ncave, broader than stalk, dark brown. Rudimentary roots in 2 rows. Furrow almost always absent, but distiguishable in older canes as a flattening. Bud elongated ovate with triangular point, small, broad margins, but very flat, germination apical, nervature converging to top. Leaf sheath about eleven inches long, with fissures one-half inch long. Ligule broad and even. Ligular process almost always absent, small and stumpy when present. Leaf blades narrow, about 4–5 cms., callus yellow-green, glaucous.

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P.O.J-213, Striped.

Dr. Cross has kindly sent us a few seeds of this striped mutation of P.O.J.-213, which Mr. Fawcett has been breeding true to type for several years. Aside from color variation it appears to be

identical in other characteristics to the self-colored type, although comparative tests will be made.

*** Java 228–P.O.J.** See Plate IV, opposite page 215.

Parents Chunnee X Black Cheribón. Imported from the Argentine by the Mayagüez Station in 1917. Somewhat distributed in western Porto Rico.

Erect, fairly vigorous, good stooling. Stalks slender, purplish with heavy bloom. Internodes long, cylindrical, straight, furrow scarcely evident. Nodes broad, prominent; growth ring broad, elevated, yellow then dark brown; root band pallid; rudimentary roots in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band swollen, larger than internode. Buds ovate, broad, margin wide shouldered above, vestiture at base and apex. Leaf sheaths glabrate; throat lannate and with a sparse vestiture of hairs; collar inconspicuous, glaucous; ligule broad, fimbriate. Leaf blades erect, the tips declined, narrow, minutely but distinctly serrulate.

In the Santa Rita immunity tests and in the experimental plots at Mayagüez this kind showed less resistance to root disease and mosaic than 36–P.O J., our experience in the Argentine being exactly similar There seems no reason why it should be further cultivated.

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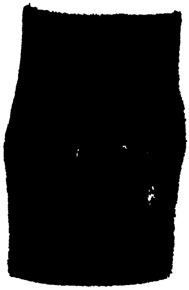
Java 234–P.O J. See Plate IV, opposite page 215.

Parents Chunnee X Black Cheribón Introduced from the Argentine by the Mayagüez Station in 1917 Somewhat distributed on the west coast.

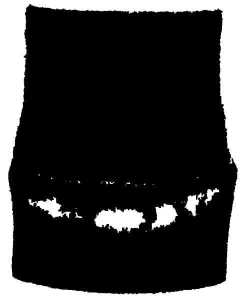
Erect or at length somewhat declined, very vigorous, heavy stooler. Stalks long, slender, usually less than 2½ cm, dull greenish with red flush Internodes long, cylindrical or slightly larger below, straight, furrow scarcely evident Nodes broad, enlarged; growth ring broad, yellowish, even; root band enlarged; rudimentary roots obscure, scarcely evident; leaf scar glabrous, narrow, appressed behind; glaucous band clearly marked, not constricted Buds small, orbicular, becoming hemispheric, glabrous. Leaf sheaths glabrous; throat lannate and with scanty vestiture of hairs; collar inconspicuous, glaucous; ligule very broad, minutely fimbriate. Leaf blades spreading, numerous, narrow, hanging long on the stalk, slightly serrulate.

PLATE IV



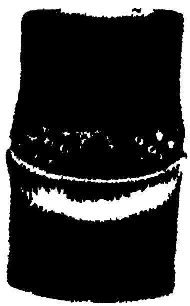
P. O J 228

P O J 234

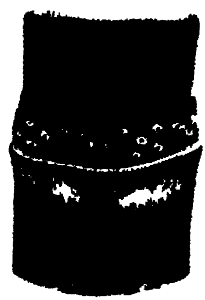


P. O. J 826

P. O J 972



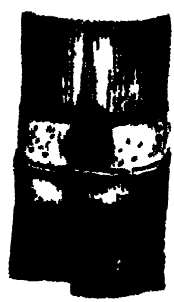
P C J 1228



P O J 2379

P. O. J. 2725

Cayanna 10



Kavangire

Illustrations by
Mario BRAU.

This seems to be closely similar as plant to 36–P.O.J. in cultural characters and to be equally valuable as such though in the stubble crops it falls down badly in successive yields. It also is less tolerant of mosaic than 36. It cannot be strongly recommended for the districts that are completely invaded by mosaic P.O.J.–36 appearing to be very much more satisfactory from every standpoint but it should not be planted elsewhere for every stalk on the Island is infected, with the exception of the plats here at the Station and at Hatillo Fruit. While the disease does not injure the growth of P.O.J.–36, it would be an active center of infection if planted among healthy cane. Little analytical data is available (see P.O.J.–105).

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P.O.J.–826. See Plate IV, opposite page 215.

A cross of Chunnee with Cheribón in 1905. Obtained from Dr. E. W. Brandes, Senior Pathologist in Charge of the Office of Sugar Plant Investigations of the U. S. Bureau of Plant Industry in May, 1924 One of the thickest and finest looking of all of this series, with the most remarkably erect growth that the author has seen in any cane. In tonnage experiments at the Station and in substation at Bayaney, on typical hillside land of that section, at "Los Caños", on quite good *vega* land. and on the poor, shaly hillsides at the Hatillo Fruit Farm, it is showing up splendidly. No data are as yet available as to its sugar content, however.

Erect, fine vigor, arrows prolifically and early Stalks long and fair girth, purple, heavy bloom Internodes long, cylindrical, perpendicular to stalk, furrow broad and flat. Nodes prominent; growth ring broad and even, green to concolorous; root band wide, parallel, light yellow, then concolorous, heavy coating of wax; rudimentary roots conspicuous, few and scattered, 2–3 in row, greenish brown changing to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band even and inconspicuous. Buds large 10 × 12 mm., scarcely exceeding growth, ring, triangular-suborbicular, germination subapical, margins broad and flat, lannate, abruptly shouldered at base, light basal placs. Leaf sheaths with abundant dorsal deciduous vestiture of tawny hairs, sides glabrate, tinted, slightly glaucous, inner base very slightly tinted with purple;

throat broad and well defined, lannate, long marginal tufts, collar medium width, reaching midrib, glaucous; ligule wide 4–6 mm.; fimbriate; ligular process on one side only, 2–4 cms. long, sometimes curved. Leaf blades erect with declining tips, narrow, 4–6 cms., dark green, margins minutely and uniformly serrulated, scanty basal ciliation.

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P.O.J.–979. See Plate IV, opposite page 215.

Cross of Chunnee with Cheribón in 1905. Received through the courtesy of Dr. E. W. Brandes, Senior Pathologist in Charge of the Office of Sugar Plant Investigations of the Federal Bureau of Plant Industry in Washington, in May, 1924. After P.O.J.–826, this is about the best-looking cane of the canes of this cross in the Station tonnage plantings and in the substation at Bayaney, Los Caños and Hatillo Fruit Co. Farm.

Erect, fine vigor, arrows prolifically and early. Stalks long and rather slender, green with heavy purple flush, abundant bloom. Internodes long, almost cylindrical, slightly staggered, furrow broad and shallow to none. Nodes slightly elevated, oblique, growth ring narrow, even, concolorous; root band wide and well defined, oblique, covered with wax, concolorous; rudimentary roots small and rather inconspicuous, few and scattered, 2–4 in rows, brown; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band inconspicuous and almost even Buds almost quadrangular, medium to large, 10 × 12 mm., not exceeding growth ring, orbicular, germination subapical, margins wide almost square at top, covered with thick vestiture of closely appressed hairs, very heavy basal places. Leaf sheaths glabrate, no wax, light green; throat narrow and indistinct, lannate, with short marginal tufts; collar medium width and indistinct, reaching midrib; ligule wide, 4–6 mm., nearly even; ligular process on one side only. Leaf blades erect with declining tips, medium width, about 8 cms., dark green, margins serrated on upper two-thirds, sparsely ciliated at base.

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P.O.J.–1228. See Plate IV, opposite page 215.

Produced in 1905 from seed of P.O.J.–160, which is a cross of Chunnee with Cheribón. Imported to the Station through kindness of Dr. Brandes, of the U. S. Bureau of Plant Industry. Cross in Argentina finds it not so vigorous as the other canes here discussed. It is cultivated in a very small extension in Java. It suffers some from mosaic disease and seems to run generally lower in sugar than the P.O.J.–36, 213 and 234, also maturing rather later. It does not seem to have much promise here, although results of tonnage experiments under way must be awaited before any definite opinion can be formed

Erect and at length recumbent, fine vigor. Stalks long and slender (about diameter of P.O.J.–36) light brown base color, overlaid with heavy purple bloom. Internodes long, tendency to tumidity, slightly staggered, exceedingly broad, deep yellow furrow, flattening bud side of internode. Nodes elevated, oblique; growth ring wide, even with internode, yellowish green; root band wide, well defined, elevated, green with purplish waxy covering; rudimentary roots large, conspicuous and fairly numerous, 3–4 in rows, green; leaf scar glabrate, narrow and appressed; glaucous band broad, even and inconspicuous. Buds medium size, 8 $\times$ 10 mm., plump, not exceeding growth ring, broadly ovate, germination apical, margins flat, wide at shoulders, glabrate, short, inconspicuous apical tufts and basal place. Leaf sheaths glabrate, glaucous, green; throat medium width, lannate, with long marginal tufts; collar medium width, inconspicuous, reaching midrib, glaucous; ligule wide 4–6 mm., nearly even; ligular process on one side only, 3–4 cms., apparently deciduous. Leaf blades spreading with declining tips, narrow, 4–5 mm., dark green, margins uniformly serrulated and ciliated.

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P.O.J.–1499.

Cross of P.O.J.–385 (Chunnee X P.O.J.–100) with P.O.J.–181 (Chunnee X Black Cheribón), which is very interesting parentage. Recently received from Dr. W. E. Cross, Director of the Agricultural Experiment Station in Tucumán, Argentina, where it has shown excellent agricultural yields, but low sucrose and high fiber. In Java in 1923 this variety constituted 36 per cent of the crop of the

Kedawoeng factory and from 5 to 10 per cent of the cane extension of several other plantations. It is a strikingly handsome cane of better average girth than most of the P.O.J. types and extremely erect.

Erect, good vigor, excellent stooler. Stalks long and of medium girth, dark green, with a slight purple flush, no bloom, characteristic discolored vertical striations. Internodes long, cylindrical, at right angle to stalk, furrow trace to short, broad flattening. Nodes bulging and parallel; growth ring medium width, about three to five mm., nearly even, light green to concolorous; root band wide and prominent, parallel, yellow to concolorous; rudimentary roots numerous but scattered, in rows two to four, purple, elevated, conspicuously large; leaf-scar slightly lannated with short hairs, appressed behind; glaucous band wide, tapering, indistinct. Buds medium to large, eight by ten mm., orbicular, never reaching growth-ring, germination sub-apical, appearance of being set in flattened cavity contrasting with bulging root band; margin narrow, flat, at shoulders only, not extending to apex, lannation along fibro-vascular bundles, no apical tuft and light basal placs. Leaf sheaths sparsely lannated at back and more so at sides, glaucous, green; throat medium width, lannated with abundant short hairs, dark colored, tendency to split at sides; collar medium width, reaching midrib, glaucous; ligule medium width, three to five mm., widening at center, nearly even; ligular process long, wide and blunt, on one side only. Leaf blades spreading, medium width, about six cms., dark green with pronounced white midrib, uniformly serrulated to base. scanty basal ciliation.

P.O.J.–2221.

A cross of Kassoer and Cheribón Obtained by the writer while in Washington in May, 1925, from Dr. E. W. Brandes, in charge of Sugar Plant Investigations for the Federal Bureau of Plant Industry. This parentage would give it one-fourth *Saccharum spontaneum* and three-fourths *S. oficinarum* blood. Not sufficiently tested here as yet to enable us to judge anything of its qualities.

Reclining, good vigor, fine stooler. Stalks long and slender, green at first becoming light purple on exposure to light, heavy wax deposit. Internodes long, cylindrical, perpendicular to stalk, furrow none. Nodes slightly enlarged and parallel; growth ring medium width, 3 to 5 mm., even, green to concolorous; root band medium width, bulging, light green to brown, covered with white wax; rudimentary roots large, few and scattered, in rows two to three, purple; leaf scar glabrate, appressed behind; glaucous band wide, tapering, inconspicuous. Buds small to medium size, 5 by 7 mm., plump, sub-

orbicular, reaching growth-ring, germination sub-dorsal, margins wide and flat, on upper two-thirds only, becoming abruptly shouldered at sides, sparsely lannated, no apical tuft nor basal placs. Leaf sheaths rather closely adhering, very sparsely lannated at back, sides glabrate, glaucous, green; throat narrow, gray, lannated with short appressed hairs, few straggling, coarse hairs at margin, collar narrow, dark gray, reaching midrib, lannated and heavily glaucous; ligule narrow at sides, 2 to 4 mm., becoming wider at center, no ligular process. Leaf blades spreading, narrow, 4 to 5 cms., dark green, prominent white midrib, margins minutely and closely serrulated and ciliated to base.

P.O.J.–2379. See Plate IV, opposite page 215.

A cross of Chunnee and Cheribón made in 1911. Obtained in May, 1924, from Dr. Brandes. It is about the poorest in general appearance of any of these canes in the tonnage experiments at the Station and in the substations of Bayaney, "Los Caños" and the Hatillo Fruit Co. Farm near the Station, at which latter point Mr. Dreier finds that it is less resistant to drought than the other P.O.J. canes. It is high in fiber and Cross, after two years experience with it in Tucumán, Argentina, finds it a late maturer, although giving fair agricultural yields. It is very little cultivated in Java and does not seem particularly promising for Porto Rico.

Erect, fine vigor. Stalks long and slender (about like P.O.J.–36) purple to brownish rose, heavy bloom. Internodes long, generally cylindrical, very slightly staggered, furrow broad and shallow. Nodes prominent, elevated; growth ring broad, even with internodes, yellowish green; root band wide elevated and conspicuous, parallel, waxy coating, green with purplish tint; rudimentary roots rather numerous and conspicuous, 3–4 in rows, brownish; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band inconspicuous and generally even, covered with very short wooly hairs. Buds medium size, 8 × 10 mm., not exceeding growth ring, broadly ovate, germination subapical, margins wide and flat, abruptly shouldered above with abundant vestiture of short tawny hairs, distinct apical tufts of short hairs, heavy basal placs. Leaf sheaths with scanty deciduos dorsal basal vestiture, slightly glaucous, light green; throat narrow and indistinct, lannate, with long straggling hairs at margin; collar inconspicuous, broad, reaching midrib, glaucous; ligule exceptionally broad, 8–10 mm., fimbriate; ligular process long, on one side only, apparently deciduous. Leaf blades spreading with declining tips, medium width, about 6 cms., dark green, margins serrulated and sparsely ciliated on upper two-thirds.

REFERENCES

See under P.O.J.–979.

P.O.J.–2714.

A cross of E.K.–28 with P.O.J.–2364, which is very interesting parentage indeed. Received from Mr. G. L. Fawcett, Botanist of the Experiment Station in Tucumán, Argentina, in July, 1924. The amount of *Saccharum spontaneum* blood is only one-eighth, but it is readily recognizable. In Tucumán it has given good yields of both cane and sugar per acre and, like P.O.J.–2725, is almost immune to mosaic. One of the really promising canes for Porto Rico of this newer series of P.O.J. canes.

Erect, good vigor, fine stooler. Stalks long and of good girth, greenish-brown with heavy purple flush on exposure to sun, considerable bloom. Internodes long, cylindrical, perpendicular to stalk, furrow trace to narrow, short flattening. Nodes slightly enlarged and parallel; growth ring narrow, even in younger internodes, widening and becoming elevated when older, yellow-green to concolorous; root band wide, slightly bulging, light green to concolorous; rudimentary roots few, large and scattered, elevated, in rows 2 to 3, purplish; leaf scar glabrate and appressed behind; glaucous band narrow and inconspicuous, tapering. Buds medium size, 7 by 9 mm., ovate, reaching growth-ring, germination sub-apical, margins narrow and triangular, sparsely lannated, long, heavy apical tuft and light basal placs, some lannation along fibro-vascular bundles. Leaf sheaths heavily lannated at back, course tawny hairs, side glabrate, green; throat wide, dark lannated with short appressed hairs and a few straggling hairs at sides; collar broad, glaucous, brownish; ligule narrow at sides, 2 to 4 mm., becoming wider at center, nearly even, short, stubby ligular process, situated unusually low on throat, on one side only. Leaf blades spreading, very wide, about like P.O.J.–2725, dark green, not flat, minutely and unformly serrulated and ciliated to base.

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Brandes, E. W.—Breeding of Disease Resisting Sugar Plants for America. The Reference Book of the Sugar Industry of the World, published by the "La. Planter & Sugar Mfr.", pp. 50–7; July, 1925.

Cross, W. E.—Some notes on Cane Variety Work in Tucumán. Int. Sug. Jour., April, 1925, p. 204.

P.O.J.–2725. See Plate IV, opposite page 215.

A cross of E.K.–28 with P.O.J.–2364, which means that this cane, distinct from the Chunnee and Cheribón crosses has only one-eighth *Saccharum spontaneum* blood, which is shown by its appearance,

which is not all of the classic P.O.J. type, it being a fine-looking, thick cane resembling the noble canes in type. Obtained in 1924 from the Mayagüez Experiment Station, where it in turn was obtained from the Agricultural Experiment Station in Tucumán, Argentina, where it has given some very promising results and is beginning to be cutivated on a commercial scale. It is one of the few thick canes that resist taking mosaic diseases almost to the point of immunity, not over one-tenth of 1 per cent of infection being found even where it is surrounded by varieties 100 per cent infected. Two thousand two hundred hectares of this variety were cultivated in Java in 1922. Cross reports good sugar content in Argentina and states that of the practically immune canes in Tucumán, this has given consistently the best results of all, and that he considers it the most promising of all the newer varieties in that province. It flowers early and abundantly.

Erect, at length recumbent, fine vigor, good stooler; arrows early and profusely. Stalks long and medium girth, yellowish green to dark green with bronze flush on exposure to sun, no bloom. Internodes medium to long, cylindrical, slightly appressed at sides, slightly staggered; furrow narrow and deep, extending over half of internodes. Nodes slightly constricted and oblique; growth ring broad, even or sometimes slightly sunken, light green to concolorous; root band oblique, medium width, concolorous; rudimentary roots few, large, 2–3 in rows, purplish to concolorous, inconspicuous; leaf scar glabrate, appressed behind and prominent in front; glaucous band narrow, slightly constricted, conspicuous. Buds medium size, exceeding growth ring by one-third, oval to ovate, germination subapical, margins narrow, flat, on upper half only, lannate with short hairs, abruptly shouldered at sides giving bud an urn shape, short apical tufts, light basal placs. Leaf sheaths green inside and out, glaucous, heavily lannated at back, sides glabrate; throat broad and dark, covered with short appressed hairs, straggling hairs at margins; collar wide, reaching midrib, glaucous; ligule narrow at sides, becoming broad and peaked at center, lannated, no ligular process. Leaf blades spreading with declining tips, very broad, dark green, white midrib, margins uniformly serrated and with scanty ciliation at base.

Two serious defects of this variety are its early and prolific flowering habit and its extremely spiny leaf-sheath.

Mr. Robert L. Davis, Associate Agronomist of the Mayagüez Station wrote the author on 11th December, 1925:

"You would be interested in the planting I made on Las Mesas last Janu-

ary. The P.O.J.-2725 has made a growth up there superior to that of B.H.-10/12 or St. Croix-12/4. The soil is a porous red clay, very low in fertility."

Seen in some of Mr. Matz' plantings at Fortuna, it was making a splendid development under South-Coast conditions. It grew remarkably well on poor red clay soil at the Station when first planted here and is looking well in tonnage experiments and hillside plantings, while in the "Los Caños" and Hatillo Fruit Co. substations, the one on splendid *vega* land and the other on poor, porous red hill land of low fertility, it is showing up well. At the Bayaney substation, under hillside conditions and planted under very trying conditions as regarded moisture in the soil to the point of its being practically planted in the mud, it is not showing up so well as some of the P.O.J. varieties. At the Demonstration Farm of the Department of Agriculture near Arecibo, it has made excellent development and proven almost immune to mosaic while from Mayagüez Mr. J. A. Saldaña reported to the writer a yield of 49.9 tons per acre from a small field planted with only one three-eye seed piece in holes five feet apart. This cane was 13½ months old when cut.

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CROSS, W. E.—Experiencias con Variedades Nuevas de Cañas. *Ibid,* XIV, pp. 107–8; 1923.

Tjep.-24.

Cross of Cheribón with Kassoer, containing, therefore, one-fourth *Saccharum spontaneum* and three-fourths *S. officinarum* blood, which is promising parentage. In Argentina, under generally 100-per-cent mosaic-infection conditions, this variety has never shown the disease and has given cane of satisfactory sugar content, although rather low field yields. It is an unattractive looking cane with its always prematurely sprouted roots.

Erect to recumbent, splendid vigor, good stooler. Stalks long and thin purple, covered with heavy grayish black wax deposit. Internodes short, cylindrical, or slightly appressed at sides, perpendicular to stalks, furrow none. Nodes slightly elevated, parallel; growth-ring broad, 4 to 6 mm., slightly elevated, but very inconspicuous, yellowish-green to concolorous; root-band wide, slightly elevated, yellowish-green to concolorous; rudimentary roots large, few and scattered, 2 to 3 in rows, purple, decided tendency to premature sprouting; leaf scar glabrate, appressed behind; glaucous band

nearly even, inconspicuous. Buds small, 5 by 7 mm., sub-orbicular, reaching growth-ring, germination sub-apical, margin wide and flat, nearly glabrate, on upper half only, no apical tuft nor basal placs. Leaf sheaths sparsely lannated at back, sides glabrate, slightly glaucous, no tinting; throat wide at sides, sharply narrowing to center, lannated with short, tawny hairs, brownish; collar shaped as throat, brownish, lannated with short wooly hairs; ligule narrow at sides, becoming abruptly enlarged and peaked at center; ligular process on one side only, very long and pointed, as long as two inches. Leaf blades spreading, narrow, 4 to 5 cms., dark green, minutely and uniformly serrulated to base, scanty basal ciliation.

REFERENCES

See under P.O.J.–2714.

Kakoe.

Listed as for sale by Dr. Stahl. "Revista", 1887, page 174. Probably introduced from Jamaica, where this variety was grown. Not since reported.

Lahaina.

(Lajaína.) Given by Dr. Stahl. *Revista*, 1887, page 174, as a synonym for Borbón, which he always considered as distinct from Otaheite or Caña Blanca.

Lahaina Striped.

The records show that a cane was cultivated at this Station under this name in 1913. There is no indication as to its origin. The description on file reads much like the striped form of Bambú.

Light Stripe.

A cane under this name reported on in Circular 8 of this Station where yields for three cuttings and average analyses are given. The origin of this cane cannot be traced and no description is on record. It was probably Calancana, but this opinion is based on the probabilities and not on evidence. Possibly it was only Rayada.

Louisiana Purple.

See Morada.

L–511.

Seedling of T–189. Imported from Louisiana by Central Guánica in October, 1920, and part of the seed was sent to this Station where it made a satisfactory early growth, but has the unfortunate characteristic of stopping development at seven or eight months. This is the only one of the Lousiana seedling so far imported. It is supposed to be an even better early cane than D–74, but results both

here at the Station and on the Hatillo Fruit Farm have been anything but satisfactory and the cane gives little promise of success here. It was by the far poorest developed of twelve varieties seen on the hill-side *finca* of Don Paco Solá near Caguas on 9th October, 1924.

The following letter from Mr. T. D. Boyd, Assistant General Superintendent at Guánica Central in 1921, in which he quotes a letter from Mr. W. G. Taggart, Assistant Director of the Louisiana Sugar Experiment Station in Audubon Park, New Orleans, gives some interesting information as to the description of this cane under mosaic conditions:

SOUTH PORTO RICO SUGAR CO. OF PORTO RICO
ENSENADA, PORTO RICO

OCTOBER 7TH, 1921.

MR. E. D. COLÓN,
Director, Insular Experiment Station,
Río Piedras, P. R.

DEAR SIR:

I have a letter from Mr. W. G. Taggart, Assistant Director of the Sugar Experiment Station at Audubon Park, New Orleans, dated September the 27th, as follows:

"In reply to your letter of September 1, I am inclined to believe that you have gone into a problem which we have been studying for the last few years. The cane known as L–511 as grown on Oak Lawn plantation was grown from one stalk carried there by Mr. Chiquelin in 1912, and we find it, when grown at the Station, to be somewhat different from our L–511. I am enclosing you a comparative description of the two canes and hope that from it you can distinguish the L-511.

"We are not sure whether Oak Lawn has gotten some other cane confused with L–511 or whether the one stalk which was originally carried there varied slightly from the rest that we kept. At any rate, the Oak Lawn cane has continued to yield a very rich juice, and with the exception that it is not very resistant to mosaic, it is a valuable cane to us. My personal opinion is that the difference is due to the conditions under which the two canes have been grown and the possible effect of the mosaic disease on the L–511 here. In fact, I can see a closer resemblance in the cane that has been growing under mosaic conditions for two years to L–511, than the Oak Lawn cane which has been growing under mosaic conditions for one year."

COMPARATIVE DESCRIPTION OF L–511.

Oak Lawn Cane	Station Cane
Growth	
Tall and upright	Medium height and upright
Top	
Short and tapering	Very short and tapering

Foliage

Medium width long and well curved	Broad long and well curved, younger than Oak Lawn cane

Leaf Sheath

Light yellow green free from hair	Light yellow green but green more mottled some hair

Node

Smooth rootlets round	Slightly raised inclined to grow

Eyes

Round	Elongated

Color of Cane

Yellow	Yellow

Effect of Mosaic

None on color	Narrow purple stripes

I hope that this information will enable you to distinguish the two forms of the same variety as suggested by Mr [illegible]

Very truly yours

(Signed) [illegible]
[illegible] Superintendent

A comparative analysis of L 511 and Cristalina as 16 month old first ratoons at the Station made on 31st March 1923 follows

Variety	Extract	[illegible]	Sucrose	Glucose	Purity
L 511	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cristalina	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

REFERENCES

AGEE, HAMILTON P —Sugar Cane Seedlings La Expt Sta Bul 127 May, '11
DODSON W R—27th Annl Rept La Agr Expt Stations 1914 In Rept of the Sugar Experiment Station by W G Taggart p 20

Lousier

Stahl page 136 This is usually supposed to Otaheite but here it seems to be used in a different sense No description is given so it can not be traced At Central Coloso it is used as a synonym for Penang Probably Stahl's Lousier — Cavengerie as the Lousier of Mauritius is this cane, as seen by the author when imported from that island to Brazil

Malabarde.

Stahl, *Revista,* 1887, page 174. López Tuero, page 10. Given as = Morada, but it is listed with the striped canes. Probably as used should be taken to = Rayada. This name cannot be traced in the literature. Malabar often occurs and usually = Yellow Caledonia.

Morada.

(= Louisiana Purple, = Black Cheribón.) Probably introduced in the early days of the nineteenth century, mixed with Otaheite. It occurs frequently in mixed plantings in all parts of the Island, but is nowhere grown in pure cultures. There seems no reason other than chance why this cane has been neglected in Porto Rico while the two other Cheribón canes, Cristalina and Rayada, are the two kinds most widely planted. It differs from them only in color, being a uniform dark purple with heavy bloom. It is equally well adapted to a wide range of cultural conditions. In a field planted at this Station in November, 1920, where there are a number of selections of Cheribón canes from different sources, this made rather the best growth and stooled rather more heavily than any of them. It is a good standard variety that has been completely overlooked here. For years it has been one of the principal canes of Louisiana. No data is at hand to show whether or not its supposed earlier maturity holds good here.

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ROSENFELD, ARTHUR H.—¿Es Superior Nuestra Caña Morada a Nuestra Rayada Revista Industrial y Agrícola de Tucumán, II, 8, pp. 331–4; 1912.

STUBBS, W. C.—Sugar Making on a Small Scale. La. Agr. Expt. Sta., Bulletin 5, Second Series, pp. 84–96; 1891.

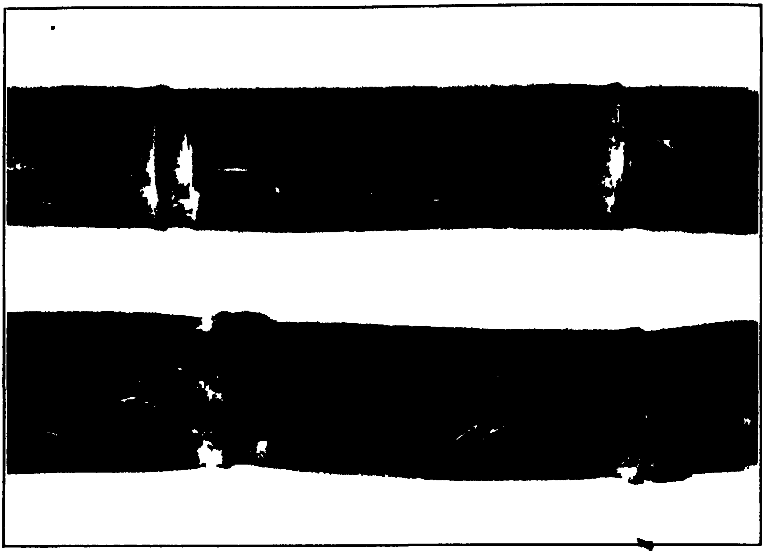
*** Otaheite.** See Plate XXIV, opposite page 227.

(= Caña Blanca = Bourbon = Lahaina.) Introduced from the other West Indies, perhaps from Cuba, in the early days of the nineteenth century. It quickly replaced the Creole and for seventy-five years was the only cane planted commercially. On account of the epidemic of 1872 its planting has been largely abandoned. It was still the only cane planted at Central San Francisco at Guayanilla on the south coast until the outbreak of gumming disease there in 1922 and it occurs rather widely in mixed and sometimes in nearly pure plantings in many other parts of the Island, especially in the hill country of the central and eastern districts.

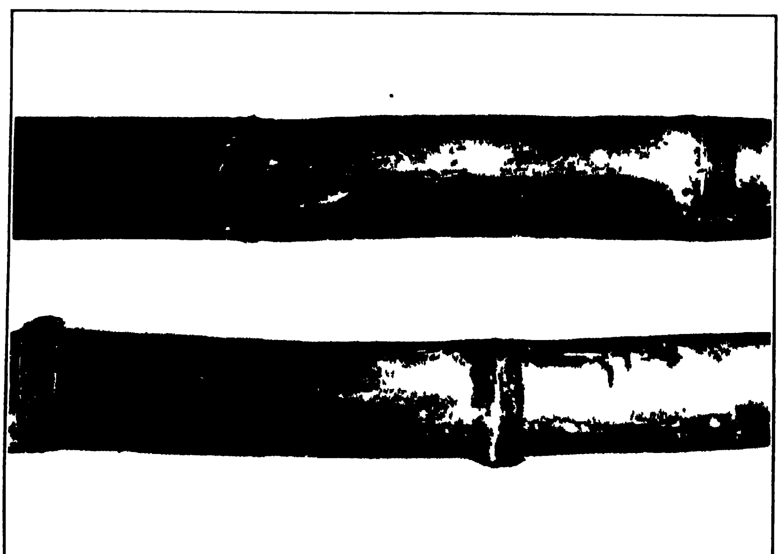
Erect but soon procumbent, vigorous on suitable soils, medium stooler, arrows frequently. Stalks long, medium stout, bright green,

PLATE XXIV

OTAHEITE



G. C. 493



yellow at maturtty, sometimes faintly tinted when fully exposed but without a distinct flush, bloom scanty or none. Internodes long, sub-cylindrical but inclining to barrel shape, straight or a little staggered, furrow evident but poorly developed. Nodes somewhat constricted; growth ring rather narrow, even or slightly sunken, concolorous or pale brownish; root band narrow, 5 to 8 mm., concolorous; rudimentary roots distant, white, then brownish, not conspicuous, in about 3 rows; leaf scar perpendicular to stalk, glabrous, appressed behind; glaucous band clearly marked, usually constricted, narrow, 7 to 10 mm. Buds small, flat, often reddish when exposed, elliptic-ovate, acute, exceeding the growth ring by one-fourth of length, base rounded, margin narrow, 1 mm. or less, uniform, germination apical, placs of short crisped hairs at base, margin and apex with conspicuous, appressed long hairs Leaf sheaths with dense vestiture of pallid, sub-appressed, acicular hairs, greenish, somewhat glaucous; throat brown, lannate with scanty tufts of long soft hairs at the margins; collar brown well marked, not reaching the midrib, sparingly lannate, especially toward the margins; ligule medium width, tapering from about 4 mm. in center to 1 mm. at ends, margin even, ligular processes well developed, unequal, one usually 14 to 18 by 6 to 7 mm., slender but obtuse, the other broader and shorter. Leaf blade suberect, flat, long and rather narrow about 6 cm., bright but rather light green, minutely but closely serrulate, even or with scattered cilia at base.

This has been a grand cane, but unfortunately it is adapted to a narrow range of conditions, and these have ceased to exist in most cane-growing countries. That it had not deteriorated was shown by its behavior at the Central San Francisco where on rich, porous, alluvial lands, the soil conditions for which it is fitted, it was still giving highly satisfactory results up to five years ago. It is reputed to be the same cane as the Lahaina of Hawaii and the Bourbon of the British West Indies. Whether this is really the case can only be determined by further comparative studies, for which material has not been available. The buds illustrated by Fawcett as those of Lahaina (Rev. Agri. Tucumán, 10; 139, 1919) are too broad to be typical for Otaheite. Here it is heavily mixed with the similar but clearly distinct cane described on another page as Penang, though its right to that name is very doubtful. The native field men distinguish the two kinds readily and never confuse them, always calling the Otaheite "Caña Blanca" and often calling the other Borbón. Both Dr. Stahl and López Tuero considered Otaheite and Borbón as distinct, but they also recognized Penang as being a third kind.

Otaheite is and always has been a poor ratooner. The present practice on the south coast of ratooning but little or not at all comes largely from the fact that till recently Otaheite was the only cane planted there. It deteriorates quickly in the field after reaching maturity and cannot be safely left over for *caña quedada* or long crop. It has always been considered here as an early maturing cane, although in Peru and Hawaii it is harvested up to 24 months old and seldom at less than 20, and as being the standard of excellence in sweetness and milling qualities. These claims are not well supported by the analyses in our files. As will be seen below, in every single case where direct comparison is possible with Cristalina from the same field the latter has proven the better, —and more conspicuously so early in the season than at full maturity. The highest record we have is about equal to the best recorded from Cristalina. It is hard to understand why all the early planters so greatly preferred it to the latter kind:

Kind	Date	Age	Extr	Brix	Sucr	Red sug	Purity	Fiber
Otaheite	1 5 21	15 mo	66.6	11.26	10.69	2.13	74.96	13.36
Cristalina	1 5 21	15 mo	66.6	16.96	15.35	0.36	90.56	11.35
Otaheite	12 10 20	15 mo Rat	73.0	17.0	11.16	0.39	[illegible]	13.30
Cristalina	12 10 20	15 mo Rat	70.0	17.30	15.53	0.28	88.74	9.60
Otaheite	1 26 21	15 mo Rat	71.1	15.85	12.66	1.56	79.87	13.87
Cristalina	1 26 21	15 mo Rat	70.3	17.85	16.14	0.53	90.42	10.69
Otaheite	1915	Plant		14.98	15.10		87.6	
Cristalina	1915	Plant		17.98	16.55		92.0	
Otaheite	May 1916	Ratoon		18.[illegible]	17.0		92.89	....
Cristalina	May 1916	Ratoon		18.8	17.8		94.14	
Otaheite	Apr 1917	Pl 14 mo		[illegible]	20.10		94.30	....

This last is our highest record for Otaheite; no comparable analysis for Cristalina was recorded, but it is clear from the above that before reaching full maturity Cristalina is the sweeter cane, a fact that will come as a surprise to most growers. In tonnage Otaheite is likely to lead Cristalina as plant cane on well-drained alluvial soils, but the reverse will be the case for most other locations and always for ratoons.

It is perhaps useless to have spent so much time discussing this interesting old variety, since its doom is now sealed. It is being definitely discarded in its last stronghold among the hills because it is so heavily infected by gum disease in practically all of that region. It seems to be the most susceptible of all canes to this very serious trouble, although Penang and Bambú are probably in the same class. Rayada and Cristalina are also attacked by it but suffer much less seriously, while Yellow Caledonia, Cavangerie and D-109 seem to be practically immune. Otaheite is also extremely susceptible to root disease in all of its forms, to the vascular bundle fungus, and to

mosaic. Its susceptibility to all of these serious troubles is so great that it should be ruthlessly exterminated.

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Palo Rojo.

See Bois Rouge.

Palo Rojo Claro.

See Bois Rouge Blonde.

*** Penang.**

This name, as used here, applies to Porto Rico only. Penang is usually considered as = (Salangore, but this is quite distinct.) Introduced by Dr. Grivot Grand-Court prior to 1879, probably from Guadalupe. It was still planted in pure cultures at Central Coloso, a few years ago, where it was also known as Lousier. Frequently occurring in mixed plantings in all parts of the Island. It has been brought to the Station from Bayaney under the name of Borbón. More likely to be confused with Bambú than with Otaheite by most planters.

Erect, often soon procumbent, good average vigor, good stooler, arrows frequently. Stalks medium diameter, light green, not yellowish, no flush, little or no bloom. Internodes rather long, cylindrical, straight, furrow shallow, poorly defined. Nodes slightly constricted; growth ring broad, 2 to 5 mm., swollen, concolorous; root band narrow, 6 to 10 mm., concolorous, rudimentary roots few, distant, large, whitish with purple centers, in about 3 rows; leaf scar perpendicular, glabrous, appressed, behind; glaucous band narrow, well defined. Buds triangular-ovate, obtuse, 9 to 10 by 9 to 10 mm., often only reaching and never exceeding the growth ring, margin 1½ to 2 mm., flat, slightly wider below, germination subapical, greenish or purplish, nearly glabrous. Leaf sheaths with medium vestiture of short pallid subappressed hairs, glaucous, with a conspicuous lilac tinge, throat pale brown, minutely and sparingly lannate, with conspicuous tufts of marginal hairs; collar pale brown glaucous, sparingly lannate, toward the margins; ligule narrow, 1 to 3 mm., tapering toward the margins, edge even; ligular processes none. Leaf blades long, spreading, medium width, about 6 cm., dark green, minutely serrulate.

No conjecture can be made as to the true name of this cane.

If it is the Lousier of Mauritius, which seems possible from its history, then that cane is abundantly distinct from Otaheite. It has been so long associated with the name Penang in this Island that that name is provisionally retained for it. It is evidently better adapted to old, compact lands than the Otaheite and it is a better ratooner. According to notes left by Mr. Crawley, the former Director, this was the principal kind planted at Central Coloso in 1913 and its planting was then being extended at other points on the west coast. It was highly recommended by Dr. Stahl, who considered it immune to the epidemic of 1872. Its planting is now abandoned at Coloso on account of its susceptibility to mosaic. Our notes indicate that it is heavily attacked by gum disease, but in this there may have been confusion with Bambú, the two having only recently been clearly distinguished. In an experimental planting of many varieties made in November, 1920, this kind took a high place for germination, stooling and general vigor.

The following analyses are available.

Kind	Date	Age	Irr	Extr	Brix	Sucr	R S	Purity	Fiber
Penang	[illegible]-21	Pl. 16 mo	No	68.[illegible]	16.00	13.11	1.76	81.93	11.62
Cristalina	[illegible]-21	Pl. 16 mo	No	68.[illegible]	16.20	[illegible]	[illegible]	[illegible].19	11.[illegible]0
Penang	[illegible]-21	Pl. 17 mo	No	71.4	[illegible]	[illegible]	.87	88.61	11.44
Rayada	[illegible]-21	Pl. [illegible] mo	No	72.7	[illegible]	[illegible]	.71	[illegible]	12.00
Penang	[illegible]-11-21	Pl. [illegible] mo	No	70.[illegible]	[illegible]	[illegible].74	1.64	88.92	11.80
Penang	[illegible]-21	[illegible] 18 mo	No	[illegible]	19.70	[illegible]	[illegible]	90.00	
Cristalina	[illegible]-21	Pl. 18 mo	No	[illegible]	[illegible]	18.9	.241	96.82	
Penang	[illegible]-21	Pl. 18 mo	No	67.3	20.60	[illegible]	.791	91.47	

This indicates a came of very satisfactory quality but a little later in maturing than Cristalina. In recent tonnage experiments at the Station it has shown up distressingly poorly and seems hardly worthy of anything more than historical further attention.

Pesante. See Plate ——, opposite page ——.

A local name at Mayagüez for Java 105–P.O.J., or "Egyptian", from the name of the "Colono" on whose place it first attracted attention in that locality.

The Porto Rico Seedling Canes

Besides the canes bred at the Mayagüez and Río Piedras Stations, the former of which up to number 200 bore the letters "P.R." and the latter of which begin with 201, seedling canes have been bred at Fajardo, Fortuna and Guánica Centrals. No Fortuna seedlings remain as such, but the Fajardo seedlings are designated with the letters "F.C." and the Guánica seedings as "G.C." The production of seedlings at the Mayagüez Federal Experiment Station was

resumed about 1917 and the seedlings produced since then have been known by the letters "M.P.R." Of the old original P.R. canes, which were bred at Mayagüez from 1906 to 1911, all seem to have been lost. One of them, P.R.–68, turned up in the first Santa Rita immunity experiment, where it made a very poor record and has not been heard of since.

Sixteen of the three hundred and twenty or more kinds produced at this Station during 1912 have been selected and kept in continuous cultivation here since that time, and some of them have been considerably disseminated throughout the Island. They were described, by Earle and are discussed in the following pages. A few of these are good canes. It is probable that each of five or six of them under conditions favorable to it will produce greater tonnage and rather more sugar per acre than Cristalina and Rayada. It cannot be claimed, however, that any of them are of surpassing merit. They will average about like the best of the Barbados and Demerara canes that have been tested here. Among the large number of seedlings produced by Cowgill each year from 1913 to 1918 there are a number that are promising. Those from 1916 on have not been fully tested and have not been disseminated. They will not be discussed at this time. No seedlings were produced at this Station from 1918 to 1925, as facilities were hardly sufficient for the proper testing of those already in hand, but, with this testing well in hand in the fall of 1925, the writer through the kindly interest and efficient cooperation of Commissioner of Agriculture Carlos E. Chardón, was enabled to complete arrangements for beginning the seedling work again, with Mr. J. A. Saldaña, formerly of the Federal Station at Mayagüez, in charge of the work under the immediate supervision of the writer. The work was well and carefully planned in advance and all breeding was done with known parents, using such valuable material as BH–10(12), SC 12/4, D–117, D–109, D–74, Uba, CH 64/21, Kassoer, P.O.J.–36, 36 (M), 213, 228, 234, 826, 979, 1228, 2379 and 2725, PR–260, 328, 358, 460, etc., etc. Some ten thousand seedlings were obtained and are planted out not only at the Station, but at seedling substations on the Island. To the great regret of all associated with this splendid and painstaking young plant breeder, Mr. Saldaña passed away in June, 1926, after having seen hundreds of the seedlings produced by him starting off to a wonderful growth. He left remarkably clear and detailed notes, which will enable us to carry on the work he started with a full knowledge of all original details. The writer has never seen a large planting of new seedling make such excellent average growth in the field as have these of Mr. Saldaña's and future

varietal workers at the Insular Station are going to have some very interesting and abundant material with which to carry on their labors.

The Fajardo Seedlings

A very considerable number of seedling canes have been and are still being propagated and tested by the Central Fajardo. They are numbered under the initials "F.C." Some of them are now being extended there on a large scale. Sixty of them were included in the immunity test at Santa Rita. A number of these proved strongly resistant to both root disease and mosaic. They have none of them been disseminated over the Island and only three are in cultivation at this Station.

F.C.-140.

A seedling of D-433 (Ceniza de Fajardo), which parentage it shows clearly in its general appearance and in its susceptibility to the *Helminthosporium sacchari* leaf spot. Obtained by Director Francisco López Domínguez from Mr. Rafael A. Veve, in charge of the Fajardo Experiment Station, where this cane was bred, in spring of 1925. In Fajardo it has a good record and is starting off well at the Station. Will be planted out to tonnage experiments this fall.

Erect, then recumbent, good vigor and stooler. Stalks long, good girth, green at first, changing through purple to red as cane becomes older and finally as very old cane becoming a brillant lemon-yellow, heavy wax covering. Internodes long, appressed at sides, enlarged at base opposite bud, staggered, no furrow. Nodes constricted and oblique; growth-ring oblique, narrow in front, 2 to 4 mm., widening in back opposite bud, nearly even, green to concolorous; root-band wide, oblique, covered with heavy wax deposit; rudimentary roots numerous and crowded, small and inconspicuous, in rows 5 to 6, light purplish; leaf scar glabrate and appressed behind; glaucous band narrow, constricted, inconspicuous. Buds medium size, 7 by 9 mm., orbicular, reaching growth-ring, germination dorsal, margins wide, flat and alate, nearly glabrous, light basal placs. Leaf sheaths with heavy vestiture of short tawny hairs at back and sides, lightly tinted within and out; throat wide, dark, lannate with short wooly hairs, some long coarse hairs at margins, tendency to split at sides; collar wide, reaching midrib, glaucous; ligule narrow at sides, 2 to 4 mm. and wider at center, even. Ligular process none. Leaf blades erect with declining tips, broad, about 8 cms., dark green, very susceptible to *Helminthosporium sacchari* leaf-spot, minutely and uniformly serrulated at margins, abundant basal ciliation.

F.C.-214. See Plate III, opposite page 191.

Seedling of *D 433* Received through courtesy of Mr R A Veve, in charge of Experimental Work at Fajardo Central

Erect, at length recumbent, good vigor, fair stooler Stalks long and medium girth, ranging from greenish yellow through rose to light purple, heavy bloom Internodes medium length, cylindrical, slightly staggered, no furrow, nodes slightly elevated in front, even behind, growth ring narrow and inconspicuous, root band wide, oblique, bright green, covered with heavy wax deposit, rudimentary roots crowded, inconspicuous, 4 to 7 in rows, concolorous; leaf scar glabrous, appressed behind; glaucous band constricted and broad. Buds orbicular and plump, medium size, 10 × 12 mm, scarcely exceeding growth ring, germination subapical, margins wide, flat and glabrate, conspicuously shouldered above, purple Leaf sheaths lanate, sides glabrate, slightly glaucous, green, throat wide, lanate, long coarse hairs at margins, collar wide, well defined, reaching midrib, dark gray and glaucous, ligule narrow, nearly even, ligular processes none Leaf blades spreading with declining tips, broad, 10–12 cms, dark green, margins serrated

As is characteristic of practically all seedlings of D–433 parentage, this cane suffers very severely from the leaf spot, *Helminthosporium sacchari*, although possibly less than its sister *F C-306*. At the Station it has seemed to ratoon better than *F C-306* and Mr Veve corroborates this fact in a letter to Mr Menéndez Ramos, former Director of this Station It is also susceptible to gomosis Mr Harold Stiles wrote us from Manatí, under date of 19th December, 1924, that this variety was doing nicely for him Mr P. Richardson Kuntz, wrote us from San Antonio de los Baños, in Havana Province, Cuba, on 30th May, 1925

"Of the Fajardo seedlings F C-214 is the best, although it is not so well development as the F C-137 it has stooled better and forms a better looking stool"

REFERENCES

ROSENFELD, ARTHUR H—List of All Sugar-Cane Varieties under Trial at the Insular Station, 30th June, 1924 14th Ann Rept of the Insular Station of Porto Rico, 1923–24, pp 63–4

VEVE, R A—Reports of the Fajardo Experiment Station, 1923–26.

F.C. 306. See Plate III, opposite page 191.

Seedling of D–433(f) and D–109(m) Received through courtesy of Mr R A. Veve, in charge of Experimental Work at Fajardo Central

Erect, at length recumbent, good vigor, Stalks long and medium girth, yellowish red to brownish red with irregular discolored patches, light bloom. Internodes medium length, slightly tumid, slightly staggered, furrow slight to none; nodes constricted at back only; growth ring broad and slightly elevated, concolorous; root band medium width, oblique, yellowish to dark green, some waxy covering rudimentary roots inconspicuous, few and scattered, 3–4 in rows, purplish; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds suborbicular, medium size, 10×12 mm., scarcely exceeding growth ring, germination subapical, margins wide and flat, sparsely lannate, heavy basal placs, purplish at tips. Leaf sheaths with deciduous dorsal vestiture, sides glabrate, heavily tinted, glaucous, inner base lightly stained with purple; throat wide, lannate and well defined; collar medium width, reaching midrib, lannate; ligule narrow, 2–4 mm., nearly even; ligular process short and on one side only. Leaf blades spreading with declined tips, medium width, 8–10 cms., dark green, upper margins minutely serrulated, bases ciliate.

This variety has given splendid cultural and industrial results at Fajardo, where it has replaced their standard D–433 (Ceniza) on several hundred acres and is being rapidly extended. The writer has seen some exceptionally fine fields of this variety at Fajardo. At the Station and in other parts of the Island it has not seemed at home and, even at Fajardo, it suffers very severely indeed from the leaf spot, *Helminthosporium sacchari*, and is susceptible to gomosis, also. It ratoons fairly well where there is abundant moisture. While results under the peculiar condition of Fajardo amply justify its extension on the northeast corner of the Island, it does not seem particularly promising for the remainder of the cane area.

REFERENCES

Cook, Melville T.—Helminthosporium Leaf Spot of Sugar Cane in Porto Rico. Journ. of the Dept. of Agr. of P. R., VIII, 4, pp. 1–10; Oct., 1924.

Veve, R. A.—Reports of the Fajardo Experiment Station, 1923–26.

F.C.–306 Striped.

Mr. Luis Serrano has selected out and bred true to type a pretty striped sport of this variety which in everything but color seems identical to the self-colored type. It would be advisable to make tonnage tests of this variety in comparison with the normal type in order to determine if its composition has changed any, or its resistance to leaf-spot, along with the change in color, the which, while not probable, is possible.

THE FORTUNA SEEDLINGS

At one time seedling canes were grown at Central Fortuna near Ponce, which is now one of the Guánica properties. This work was soon discontinued and most of the seedlings have been lost. Only one was included in the immunity experiment at Santa Rita, where it made a very good record in resistance to both root disease and mosaic.

Not seen elsewhere.

THE GUÁNICA SEEDLINGS

The growing of seedling canes was begun at Central Guánica about 1908, but has been discontinued. They are numbered under the initials "G.C." These numbers reached nearly two thousand. Numbers 493, 701, 888 and some others are now grown on a large scale on the various Guánica properties. Two of the "G.C." varieties are in cultivation at Fajardo and three are in the collections at this Station. They have not been otherwise disseminated.

* **G.C.–493.** See Plate XXIV, page 227.

A seedling of Otaheite produced in 1908. Brought to the Station from Guánica by Mr. Earle in 1921. Murphey reported very well on it from Guánica from 1908 to 1913, finding it a vigorous stooler, superior looking in general to Otaheite and of higher sucrose content than its famous parent. In 1912 he reported a sucrose content of 14.5 per cent for it in January and a production of 38.3 tons per acre, calling it at the same time a "fine ratooner". He stated that it has around 50 per cent more stalks per stool than the native kinds.

Habit declined, vigorous. Stalks heavy, yellowish-green. Internodes long, cylindrical, straight; furrow none or scarcely evident. Nodes broad, not constricted; root-band broad; rudimentary roots brownish, in about 3 rows; growth ring broad, elevated; leaf scar glabrous, not prominent, appressed behind; glaucous band broad, but poorly defined. Buds sub-hemispheric, reddish, margins broad, equal, base, margin and apex ciliate. Leaf sheaths glabrate; throat minutely lannate, vestiture reduced to a few short hairs; shoulders with short lobes; ligule narrow, even; collar minutely lannate. Leaf blades declined, narrow, minutely serrulate above, even below.

In 1913 Murphey noted that this cane is of full size right to the top and could "all be utilized". Todd the same year mentioned it as promising at Guánica. Bourne in June of that year reported that it was resisting drought better than Otaheite or B–208, also that it flowered in Santa Rita. It is also said to stand the attacks of

white grubs much better than the native varieties and to need a longer period than these for thorough ripening, particularly under moist conditions (Bourne). In May, 1914, it was reported from Guánica as doing well in all places tried, both as *Gran Cultura* and as *Primavera.*

At the Station it has proven highly susceptible to mosaic disease and, while the first plantings were very vigorous, it is not at present showing up so promisingly in tonnage experiments in comparison with B.H.-10(12).

We have the following figures on production and analyses at Guánica:

Date	Tns. cane per acre	Brix.	Sucrose	Purity	Tns. sugar per acre
Dec., 1913	66.47	....	15 6	85 0	8 07
Dec., 1913	81.00	17 8	15.8	86.2	8.71
Feb., 1914	40.15	....	14.7	81.4	4.48
B-3922 1914.........	....	....	....	....	6.86
March, 1914.	45 57	....	14.7	80.9	5.07
Av. Crop 1915.....	45 78	.. ..	13.4	80.8	4.26
March, 1916.........	36.47	....	16.1	85.5	4.68
B-3922 1916	29 14	....	16.2	84.8	3.87
D-117	28.17	....	16.8	85.5	3.66

This is certainly quite a creditable record, although this variety is hardly cultivated now in Porto Rico.

* G.C.-701.

Brought to the Station from Mayagüez in fall of 1925 by Mr. J. R. Saldaña. This cane, which was evidently a very good variety at Guánica and, according to Wolcott, rather exceptionally resistant to *Diatraea* attack, seems, along with the other G.C. seedlings, most of which have already disappeared completely, or are being rapidly eliminated in favor of B.H.-10(12) and S.C.-12/4. Mr. R. L. Page told the writer that this variety had the characteristic of splitting rather badly as it ripened.

We are now multiplying this kind for future tonnage experiments at the Station, where it has not yet been fully tested.

Erect or sub-declined. Stalks numerous, heavy, pale green. Internodes medium length. Nodes slightly constricted; root-band narrow; rudimentary roots with brownish centers in 2 or 3 rows; growth ring conspicuous, elevated; leaf scar short, heavily ciliate with pallid hairs; glaucous band narrow, somewhat constricted. Buds ovate, the margin shouldered above, at first flat, soon developing and prominent, often sprouting; apex and base minutely barbed. Leaf sheaths with heavy vestiture; shoulders both lobed; throat lannate but with scanty vestiture; ligule medium width, nearly even; collar lannate. Leaf blades declined, broad, serrulate throughout.

* **G.C.–1480.**

Brought to the Station in fall of 1925 by Mr. J. A. Saldaña from Federal Agricultural Experiment Station in Mayagüez.

Erect, vigorous. Stalks stout, dull green tinted with red, quite glaucous. Internodes long, sub-cylindrical, nearly straight; furrow well marked. Nodes medium width, constricted; growth ring depressed; root-band narrow; rudimentary roots 2 to 3 in rows, often developing in the standing stalk; leaf scar glabrous, prominent, appressed behind; glaucous band poorly defined, blending with the bloom of the internode. Buds large, ovate-triangular, acute, appressed, but soon developed and prominent; margins broadest at base; apex and base barbed. Leaf sheaths with rather scanty vestiture; shoulders seldom lobed, throat with scanty vestiture and scarcely lannate; ligule short, even; collar glabrous. Leaf blades erect with tips declined, broad serrulate to base.

* **G.C.–1486.**

Brought to the Station from the Federal Experiment Station in Mayagüez by Mr. J. A. Saldaña in the fall of 1925. It is now being multiplied for planting out in tonnage experiments.

Erect, vigorous. Stalks stout, green with red-brown tints when exposed, at length quite dark. Internodes tumid, inequilateral, slightly staggered; furrow evident. Nodes broad, somewhat constricted; root-band broad; rudimentary roots in 3 or 4 rows, often developing on the standing cane; leaf scar glabrous, prominent, appressed behind; glaucous band well marked. Buds large, triangular, appressed, then prominent; margin broad, inconspicuous, lobed, glabrate. Leaf sheaths with dense vestiture; throat with abundant vestiture extending up the leaf margins; ligule short, even; collar lannate, broad, the lobes brownish, the center pallid. Leaf blades broad, crowded, short, acuminate, sharply serrulate almost to base, margin ciliate at base.

M.P.R.–50.

Seedling of G.C.–1486. Brought to Station from Mayagüez in October, 1924, by Mr. J. A. Saldaña. This is about the best known of the Mayagüez seedlings, but as yet there has not been time to extend it sufficiently for definite trial at the Insular Station.

Erect and then recumbent, good vigor, fine stooler. Stalks long and stout, green to yellow, some flush and occasional perpendicular striations, scanty bloom. Internodes short to medium length, tumid, slightly staggered, no furrow. Nodes constricted and parallel; growth-ring narrow, 2 to 4 mm., widening at outer margin of curve, slightly sunken, bright red to concolorous; root band wide, yellowish-green

to concolorous; rudimentary roots large and prominent, few and scattered, 3 to 4 in rows, purplish to brown; leaf scar broad and prominent in front and appressed behind, glabrate; glaucous band medium width, constricted and conspicuous. Buds medium size, 7 by 9 mm., orbicular, plump, reaching growth-ring, germination sub-dorsal, margins medium width, on upper half only, abruptly shouldered at sides, purple, covered with scanty vestiture of short hairs, wide, sparse apical tuft, light basal placs. Leaf sheaths with heavy vestiture of coarse hairs at back, margins glabrate, green, glaucous; throat broad, dark brown, covered with long, coarse hairs, which are especially abundant at sides; collar broad, reaching midrib, glaucous, dark brown, covered with minute hairs; ligule narrow at sides, wider and concave at center; no ligular process. Leaf blades spreading, medium width; about six cms., not flat, dark green, minutely and uniformly serrulated at margins, long, coarse, basal ciliae.

THE PORTO RICO SEEDLINGS PRODUCED IN 1912

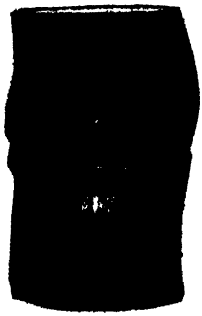
*PR-202. See Plate V, opposite page 239.

Parentage unknown.

Erect, vigorous, weak stooling, arrows occasionally. Stalks long, medium stout, green, little or no flush, heavy bloom. Internodes long, cylindrical, but enlarged below, staggered, furrow none. Nodes scarcely constricted, oblique; growth ring broad, 3 to 4 mm., swollen, the widest part of the stalk, conspicuous, yellowish-brown; root band oblique, 6 to 10 mm., tapering downward, concolorous; leaf scar glabrous, appressed behind; glaucous band scarcely constricted, partially obscured by the bloom of the internode. Buds subhemispheric, plump, about 12 by 12 mm., not exceeding the growth ring, margin narrow, uniform, germination subapical, basal placs well developed, marginal and apical vestiture of long hairs and a short appressed pubescence extending well up on the sides of the bud. Leaf sheaths with a short vestiture when young, becoming glabrate, green, somewhat glaucous; throat narrow, densely lannate and with a sparse vestiture of short hairs on the margins; collar narrow, not reaching the midrib, dark brown, glaucous, the margins lannate; ligule short, 2 to 3 mm., minutely fimbriate; ligular processes none. Leaf blades erect except the tips, conspicuously plicate and revolute, broad, 9 cm. or more, minutely but sharply serrulate to the base, not ciliate.

This according to Earle, is a cane that is adapted to either low or hill lands. It does not mature quite as early as the Cristalina, still it may be used for either fall or spring planting. It does not usually ratoon well, and its disease resistance has not been fully tested. It was not included in the Santa Rita Immunity experiment.

PLATE V



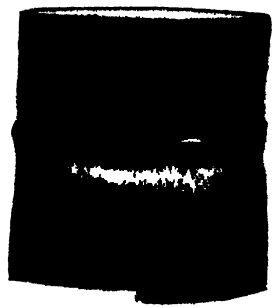
Kassoer

P. R. 202

P. R. 208

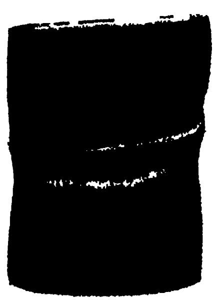
P. R. 260

P. R. 292

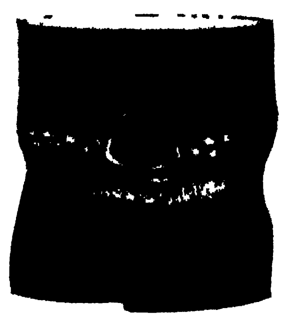


P. R. 328

P. R. 358



P. R. 433



P. R. 492

Illustrations by
Mario BRAU.

The following selected analyses show about how it ranks as a sugar producer.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-202	4-25-17	Rat.	....	....	22.75	20.90	....	91.86	....
PR-202	Apr. 1918	Pl. 11 mo.	....	....	19 98	17.78	....	88.96	....
PR-202	4-28-19	Rat. 11 mo	....	....	19.60	17 68	....	90 63	....
PR-202	1-13-20	Rat. 8 mo	....	61.90	14.42	10 77	.. .	74 68	....
Cristalina	1-13-20	Rat. 8 mo	....	....	....	16.85	....	....	....
PR-202	1-13-20	Pl. 10 mo	....	64.58	18.66	16.78	..... .	89 65	....
PR-202	12-8-20	Rat. 10 mo	No	71.4	13 18	10 27	3.10	72 68	8.0
Rayada	12-8 20	Rat. 10 mo	No	71.1	15.83	13.45	1 76	84.96	8.08
PR-202	2-2-21	Rat. 10 mo	No	67 05	17.75	15.71	0.95	88.5	11.70
PR 202	2-2-21	Rat. 10 mo	Yes	67.08	19.15	16 77	0 79	87 57	11.77
PR-202	2-7-21	Pl. 16 mo.	No	62 5	18 10	16 26	0.71	89 87	11.55
Cristalina	2-7-21	Pl. 16 mo.	No	68.6	17 90	16.14	0 808	90.16	13.81
PR-202	4-29-21	Pl. 18 mo	No	60.7	20.10	18 57	0.168	92.38	....
PR-202	1-17-23	Pl 13 mo.	No	....	19.70	17.28	....	87 70	....
PR-202	2-18-23	Pl. 14 mo.	No	....	17.70	15.30	....	86.50	....
PR-202	3-19-23	Pl. 15 mo.	No	....	17.00	14.59	....	85 70	....

The last three analyses are from Central Aguirre, where Mr. Earle had extensive plantings of most of the varieties tried out at the Insular Station. He remarks that it should be discarded for poor germination. While inclined to think the cane should be discarded for its poor germination, the author would also include in the count poor stooling and ratooning. The ratooning has always been particularly poor within his observations. In March, 1924, the author went over a field at the Hatillo Fruit Farm, which carried P.R.–208 and 271 as first-year stubble. The plant had been cut for seed the previous September and the P.R.–271 had ratooned excellently, while the P.R.–202 did not show 1 per cent of the stools ratooned. A planting of P.R.–202 at the Station along with most of the other P.R. seedlings in September, 1924, confirms Earle's statement that this variety should be discarded for poor germination. It is quite susceptible to leaf-spot.

* **PR–207.** See Plate XXV, opposite page 241.

Parent, B–306 (= B347).

Erect, good to medium in vigor and stooling, arrows frequently. Stalks medium length and diameter, green at length with faint pink flush, light bloom. Internodes medium length, somewhat larger below, nearly straight, furrow none. Nodes somewhat constricted, only slightly oblique; growth ring medium width, elevated, concolorous; root band narrow, 6 to 8 mm., concolorous; rudimentary roots large, crowded, whitish, in 3 rows; leaf scar glabrous, narrow, appressed behind; glaucous band a little constricted, poorly defined. Buds oval-ovate, obtuse, about 9 × 12 mm., exceeding the growth ring, margin narrow, equal, germination subapical, basal places short and

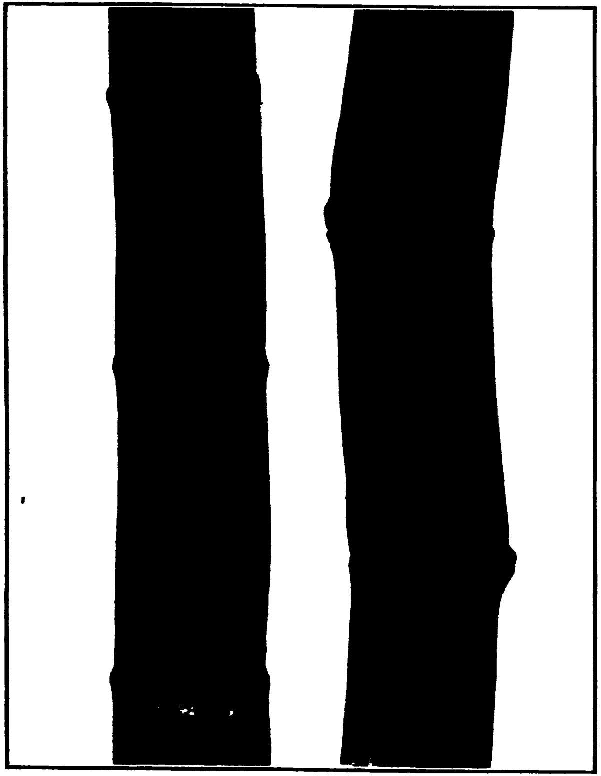
inconspicuous, marginal vestiture scanty. Leaf sheaths with a short midrib, glaucous, the margins lannate; ligule narrow, 2 to 3., even, appressed vestiture, sometimes becoming glabrate, green or slightly tinted, glaucous; throat densely lannate, vestiture of long hairs scanty, mostly on the margins; collar well marked, reaching the midrib, glaucous, the margins lannate; ligule narrow, 2 to 3 mm., even; ligular processes rather short and broad, obtuse, on one side only. Leaf blades erect, the tips declined, flat, 6 to 7 cm., dark green, serrulate to the base, not ciliate.

This cane grows less rapidly at first than some of the others but it ultimately makes a good tonnage and ratoons well. It is a medium-season cane, not maturing quite as early as Cristalina, still it may be used for spring planting. Although it arrows freely if planted early, spring plantings seldom arrow and may be carried over. At the Station, planted, in May, 1918, it was not cut till April 1920 at 23 months old. It was in perfectly good condition, showing very few rotten canes. It is best planted in *vega* lands, but does fairly well in the hills. Its disease resistance has not been fully tested.

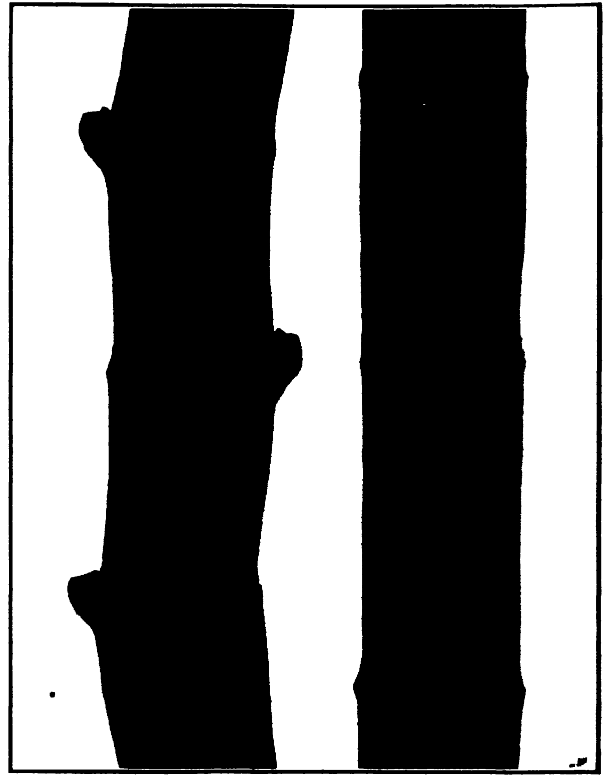
As seen from the following analyses, it developes very satisfactory sucrose and purity:

Kind	Date	Age	Arr	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-207	4-24-21	Pl.	....	......	19.1	17.55	....	91.8	....
P R-207 ...	April, 1918	....	.	...	19.50	16.79	......	85.84	....
P R-207	6-1 18	Rat.	....	....	18.86	16.80	....	88.92	....
P R-207	4-29-19	Rat.	.. ..	....	20.0	18.80	....	90.40	....
P R-207	1-18 20	Rat. 8 mo..	. .	61.90	16.09	12 59	....	78.24	....
Cristalina ..	1-18 20	Rat. 8 mo..	....	......	......	16.85	....	....	....
P R-207	1-18-20	Pl. 10 mo...		64 97	17.22	14.51	...	84.26	....
P R-207	April, 1920	Rat.	.. ..	60.0	21.54	19.04	....	88.39	....
P R-207	1-14-20	Pl. 20 mo..	.. ..	62 88	18.68	17.13	....	91.70	....
Cristalina ...	1-14-20	Pl. 20 mo..	.. .	60.22	17.46	15.98	....	91.28	....
P R-207	1-21-21	Pl. 15 mo.. .	No.	67 10	16.8	14 28	1.26	85.0	13.16
Cristalina ...	1-21-21	Pl. 15 mo.. .	No..	70.0	17.25	15.96	0.87	92.52	9.60
P R-207	2-14-21	Pl. 16 mo.. .	No..	72 4	18.30	15.84	1.08	86.55	13 25
Rayada.....	2-14-21	Pl. 16 mo..	No..	68 6	17.15	15.25	0.81	88.92	12.87
P R-270	4-29 21	Pl. 18 mo....	No..	62.9	17.70	16.06	0 485	90.58	... .
P R-207	1-17-23	Pl. 13 mo....	Yes	....	16.80	12.58	....	74.60	... .
P R-207	2-18-23	Pl. 14 mo....	Yes	....	17.60	13.35	....	75.90	....
P R-207	3-19-23	Pl. 15 mo....	Yes	....	15.00	10.01	....	66.80	....

The last three analyses are from the records of Mr. Earle's experimental plantings of this variety at Aguirre, along with other P. R. seedlings. The analyses seem to amply justify his conclusion that this cane was of no value there—in fact the writer is inclined to think that those observations would apply anywhere and has discarded it from Station experiments. Mr. Luis Serrano, Assistant Agronomist at the Station, who helped him to make the selections of the earlier seedlings, agrees with him on this point.



P. R. 207



P. R. 209

Planted in the fall of 1924 alongside P.R.-292, 358 and 433, it proved decidedly inferior to the other three in general development, girth of stalk, stooling and susceptibility to *Helminthosporium* spot.

* **PR-208.** See Plate V, opposite page 239.

Parentage unknown.

Erect, but at length declined, only medium vigor and stooling, seldom arrows. Stalks of medium length and diameter, green then yellowish with a pronounced red flush, light bloom. Internodes medium length, enlarged below and somewhat shouldered on side opposite bud, furrow well marked. Nodes constricted, but slightly oblique; growth ring narrow, often sunken, greenish; root band narrow, 6 to 8 cm., tapering downward, darker green; rudimentary roots small, crowded, brownish, in 3 or sometimes 4 rows; leaf scar glabrous, appressed behind; glaucous band constricted, about 8 mm., well defined. Buds triangular-ovate, apex narrow but obtuse, about 12 × 14 mm., exceeding the growth ring by one-third or one-half, margin medium width, a little wider below but not shouldered, germination apical, basal placs well developed, and with sparse marginal and apical vestiture Leaf sheaths with a dense but rather short assurgent vestiture, green or slightly tinted, glaucous, somewhat stained with purple at base within; throat densely lannate, and with an abundant vestiture of medium-short hairs on the margins and behind the ligule, conspicuously pouched and wrinkled; collar conspicious, dark brown, reaching the midrib, glaucous and lannate nearly to the middle, ligule abruptly wider at center, reaching 4 or 5 mm., the ends narrow, nearly even; ligular processes none or poorly developed. Leaf blades suberect, the tips declined, broad, flat, reaching 8 cm., dark green, minutely serrulate to the base, not ciliate

This averages the richest in sucrose of any of the Porto Rico seedlings, but it can not be recommended for general planting since it does poorly on poor, dry, lands, where it suffers considerably from root disease It is a desirable cane for rich, moist land and responds readily to increased applications of fertilizers It develops sucrose fairly early but continues to make growth for a long season. It has been tested as a long-crop cane by Mr. Dreier and is well adapted to holding over. It may be planted either in fall or spring.

In the Santa Rita tests it proved to be rather more resistant to mosaic then Rayada. It has not been tested for gum disease. It is sometimes badly eaten by rats, as are most very sweet canes.

In a variety test at Central Mercedita, Yabucoa, on rich cow-penned land, cut February, 1920, as plant cane of 17 months, this

gave: tons per acre, 57.35; brix, 15.7; sucrose, 13.58; purity, 86.3. It was evidently still immature.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-208	4-24-21	Pl.	....	....	19.3	18.44	....	95.5	....
PR 208	5-4-16	....	....	....	19.4	18.44	....	95.06	....
PR-208	4-25-17	....	....	....	24.80	23.10	....	93.41	....
PR-208	2-12-18	Pl.	....	....	15.70	12.59	....	80.19	....
PR 208	1-8-20	Rat. 14 mo.	....	58.18	17.12	14.71	....	85.92	....
PR-208	12-10-20	Rat. 10 mo.	No	75.0	14.43	11.04	2.58	76.48	8.0
Rayada	12-10-20	Rat. 10 mo.	No	71.1	15.83	13.45	1.76	84.96	8.08
PR-208	12-22-20	Rat. 14 mo.	No	72.0	17.68	15.57	0.89	87.97	7.84
Cristalina	12-22-20	Rat. 14 mo.	No	70 0	17.50	15.58	0.28	88.74	9.50
PR-208	1-28-21	Rat. 15 mo.	No	72.7	18.15	16.43	0.71	90.18	13.15
Cristalina	1-28-21	Rat. 15 mo.	No	68.6	17.90	16.14	0.808	90.16	13.81
PR-208	1-19-21	Pl. 15 mo.	No	70.2	20.35	18.52	0.31	91.0	9.58
Cristalina	1-19-21	Pl. 15 mo.	No	70 0	17.25	15.96	0.37	92.62	9.60
PR-208	2-14-21	Pl. 16 mo.	No	70.2	18.75	17.0	0,71	90.66	10.36
Rayada	2-14-21	Pl. 16 mo.	No	68 6	17.15	15.25	0.81	88.92	12.37
PR-208	4-29-21	Pl. 18 mo.	No	65.6	21.26	19.90	0.168	93.50	....
Cristalina	4-29-21	Pl. 18 mo.	No	65 1	19.55	18.93	0.241	96.82	....

***PR-209.** See Plate XXV, opposite page 241.

Parentage unknown.

Erect, or sometimes tardily decumbent, good vigor, medium stooling, sometimes arrows. Stalks long, medium diameter, green, then yellow, with faint reddish flush, no bloom. Internodes medium to short, lightly compressed, strongly staggered, furrow none. Nodes prominent, scarcely constricted, oblique; growth ring broad, 2 to 4 mm., elevated, concolorous, then brownish; root band oblique, 6 to 10 mm., concolorous; rudimentary roots large, crowded, yellowish, in about 3 rows; leaf scar minutely appressed, ciliate then glabrate, appressed behind; glaucous band about 8 mm., scarcely constricted, well defined. Buds broadly ovate or subhemispheric, obtusely rounded, about 12 to 14 $\times$ 12 to 14 mm., exceeding the growth ring by one-fourth to one-third, margin narrow but shouldered, germination dorsal, often germinating prominently on the standing stalk, basal placs well developed, marginal vestiture scanty but ending in a conspicuous apical tuft. Leaf sheaths with heavy vestiture of appressed white hairs, green, glaucous, faintly stained with purple at the base within; throat densely lannate and with an abundant vestiture of long hairs on margins and behind ligule; collar broad, reaching the midrib, lannate; ligule medium, about 3 mm., even; ligular processes sometimes present, often poorly developed. Leaf blades erect except the tips, somewhat two-ranked, flat, broad, 9 to 10 cm., dark green, minutely serrulate, the base even and ciliate.

This is another cane that can only be recommended for moist, rich soils. It is a failure on poor hill land. Where conditions are favorable it makes heavy tonnage and develops a good degree of sucrose. It responds to heavy applications of fertilizers on moist lands.

It is better for fall than for spring planting. In the Santa Rita experiment it suffered more than Rayada from both root disease and mosaic. It has not been tested for gum disease, nor will it be, as we have decided to abandon it at the Station and it has not been distributed.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-209	4-24-18	Pl.	......	....	17.4	15.44	....	90.4	....
P R-209	5-4-16	....	......	....	16.4	14.50	....	88.41	....
P R-209	4-15-17	....	......	....	22.38	20.50	....	91.60	....
P R-209	April, 1918	Pl.	......	....	16.30	13.55	....	81.80	....
P R-209	4-28-19	Rat.	......	55.0	19.20	17.4	....	90.63	....
P R-209	1-13-20	Rat. 8 mo....	......	63.33	13.38	9.72	....	72.64	....
Cristalina ...	1-13-20	Rat. 8 mo....	......	....	....	16.35	....	....	....
P R-209	April, 1920	Rat. 11 mo....	......	68.91	19.41	17.31	....	88.25	....
P R-209	12-13-20	Rat. 10 mo....	No..	71.60	14.79	11.71	2.11	79.1	10.22
Rayada......	12-13-20	Rat. 10 mo....	No..	71.10	15.83	13.45	1.76	84.96	8.08
P R-209	1-21-21	Pl. 15........	Yes.	64.8	17.30	15.02	1.15	86.82	12.85
Cristalina ...	1-21-21	Pl. 15........	No..	70.0	17.25	15.96	0.87	92.52	9.60
P R-209	2-14-21	Pl. 16.......	No..	68.0	18.75	17.05	0.62	90.93	12.37
Rayada......	2-14-21	Pl. 16........	No..	68.6	17.15	15.26	0.81	88.92	12.37
P R-209	4-30-21	Pl. 18........	No..	62.7	17.45	16.47	0.751	91.75	....
P R-209	4-30-21	Pl. 18........	Yes.	65.7	18.50	16.98	0.628	91.78	....
P R-209	1-17-23	Pl. 13 mo....	Yes	.. ..	18.80	16.26	....	86.50	....
P R-209	2-19-23	Pl. 14 mo....	Yes	....	17.10	13.85	....	81.00	....
P R-209	3-21-23	Pl. 15 mo....	Yes	....	17.80	15.84	.. ....	87.40	....

The last three analyses are taken from Earle's notes on his Aguirre experiments and amply justify his conclusion that P.R.–209 is of no value in Aguirre. In June, 1925, Mr. Dreier at the Hatillo Fruit Farm harvested one of the most beautiful fields of this variety that the author has ever seen, but its sugar content was so low at Central Victoria that it hardly paid expenses. It takes gumming disease.

*** PR–210.**

Parentage unknown.

Strictly erect, medium vigor and stooling, seldom arrows. Stalks medium diameter, green then yellowish, with a red flush, no bloom. Internodes medium length, cylindrical, straight, furrow none. Nodes not constricted, scarcely oblique; growth ring narrow, 1 to 2 mm., nearly even, usually concolorous or sometimes brownish; root band narrow, 6 to 8 mm., concolorous or darker; rudimentary roots small, crowded, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band about 8 mm., well marked. Buds suborbicular, often slightly wider than long, 9 to 10 × 8 to 9 mm., very slightly exceeding growth ring, margin medium, somewhat shouldered, germination subapical, basal place short, marginal and apical vestiture scanty but with more or less short pubescence well up on sides. Leaf sheaths with a moderate vestiture, green, not glaucous; throat dark brown,

strongly lannate, with an abundant vestiture of hairs on the margins; collar dark brown, glaucous, the margins densely lannate; ligule about 4 mm., the margin fimbriate and ciliate; ligular processes, one usually well developed about 12 mm., acute. Leaf blades strictly erect, narrow, 5 or 6 cm., flat, somewhat two-ranked, medium green, sharply serrulate to the base not ciliate.

This is another cane that can hardly be recommended for general planting. It requires rich land and good treatment, when it yields a heavy tonnage. It does not mature quite as early as Cristalina, still it can be used for spring planting. It grows so strictly erect that it should be planted closer than other kinds. It stands up well and is seldom damaged by rats. It was tested for the alluvial irrigated lands of the south coast by Earle and proved of doubtful value—see last analyses below.

In Santa Rita Experiment it made a good showing, being decidedly more resistant to mosaic than Rayada. On poor lands, however, it often suffers from root disease. It has not been tested for gum disease.

In the variety experiment at Central Mercedita, Yabucoa, on rich cowpenned land this cane made a fine showing, being third in tonnage. Its record was, February 1920, plant cane 17 months, tons per acre, 57.55; brix, 15.80; sucrose, 13.12; purity, 83.0. This would indicate 5.399 tons sugar per acre. Other records follow:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-210.......	4-25 18	Pl.	......	..	19 4	17.54	.. ...	90.4	....
PR-210.	5-4 16	... .	... .	.. .	17 6	16.17	....	91.87	....
PR-210 (1) ...	4-25-17	. . . .	.	. .	23 88	21 80	......	91.10	....
PR-210.......	12-8-20	Rat 10 mo.	No	71 4	14 98	11.81	2.71	79.10	9.15
Cristalina ..	12-8-20	Rat 10 mo.	No	73 0	15 68	13.41	1.78	85 75	10.80
PR-210.......	1-21-21	Pl. 15 mo . .	No	70 9	16 90	14.22	1.77	84.14	11.64
Cristalina ...	1-21-21	Pl. 15 mo .	No	70 0	17 25	16.96	0.87	92.52	9.60
PR-210.......	3 3-21	Pl. 16 mo. .	No	69 7	18.20	16.62	0.89	91.31	12.72
Rayada.....	3-3-21	Pl. 16 mo. ..	No	72 7	18.25	16 30	0 71	89.31	12.00
PR-210.... .	4-30-21	Pl. 18 mo.	No	66.6	19.50	18.06	0.491	92.11	....
PR-210	1-17 23	Pl. 18 mo. ...	No	....	17.75	13 58	....	76.50	....
PR-210	2-19-23	Pl. 14 mo. .. .	No	....	20 00	17.09	....	85.40	....
PR 210	3-21-23	Pl. 15 mo. ...	No	....	17.90	14.46	....	81.20	....

(1) Sixth in tons cane out of 47 kinds.

*** PR-219.**

Parent, D-117.

Erect, or finally decumbent, good vigor, medium stooling, arrows freely. Stalks long, medium diameter, green with a slight red flush, light bloom. Internodes medium to long, enlarged but hardly shouldered below, slightly staggered, furrow none. Nodes slightly constricted, somewhat oblique, growth ring about 2 mm., somewhat elevated, constituting the thickest part of the stalk, brownish-green;

root band 7 to 10 mm., concolorous or rather brighter green, tapering downward; rudimentary roots small crowded, pale brownish, in 4 or sometimes 5 rows; leaf scar glabrous, appressed behind; glaucous band about 8 mm., slightly constricted, well defined. Buds broadly ovate, subacute about 10 to 14 × 10 to 14 mm., slightly exceeding the growth ring, margin narrow, uniform, germination subapical, basal placs short but well developed, marginal and apical vestiture medium. Leaf sheaths with a sparing vestiture of short hairs on the back, at length sometimes glabrate, green or slightly tinted, somewhat glaucous, stained with purple at base within; throat densely lannate and with an abundant vestiture of hairs on the margins and behind the ligule; collar narrow, reaching the midrib, glaucous, the margin lannate, ligule about 3 mm., even; ligular processes sometimes one strongly developed reaching 25 to 30 mm., acute, sometimes wanting. Leaf blades erect except the tips, rather narrow especially at the base, reaching 6 cm. above the middle, flat or somewhat plicate, medium green, minutely serrulate, not ciliate above the throat. (Hardly distinguishable from D–117.)

This cane grows vigorously but it does not seem to last well in the field after arrowing, usually showing considerable top rot and rind disease It is known to contract mosaic but how badly it is injured has not been determined. It should probably be abandoned as there are many other equally good canes without these faults. Its sucrose record follows:

Kind	Date	Age	Arr	Extr	Brix	Sucr	R S	Purity	Fiber
PR 219	2 22 18	Plant			17 4	14 54		83 5	
PR 219	5-4 16	Plant			17 1	15 18		88 7	
PR 219 (1)	4 25 17	Plant			21 45	19 9		92 77	
PR 219	4 2 19	Rat 11 mo		50 06	19 7	18 0		91 86	
PR 219	Apr 1918	Pl 11 mo			18 85	16 4		85 09	
PR 219	1 18 20	Rat 8 mo		59 52	16 46	13 84		84 08	
Cristalina	1 13 20	Rat 8 mo				16 85			
PR 219	Apr 1920	Rat 11 mo		66 68	20 14	18 10		89 87	
PR 219	12 8 20	Rat 10 mo	No	78 5	13 88	9 70		70 18	7 42
Rayada	12 8 20	Rat 10 mo	No	71 1	17 88	13 45	1 76	84 96	8 08
PR 219 (2)	1 21 21	Pl 15 mo	Yes	67 2	19 10	16 82	0 94	88 06	11 15
Cristalina	1 21 21	Pl 15 mo	No	70 0	17 25	15 96	0 87	92 52	9 60
PR 219	1 17 23	Pl 18 mo	No	Aguirre	21 50	18 45		85 70	
PR 219	2 19 23	Pl 14 mo	No	Aguirre	20 00	18 85		94 20	
PR 219	3 21 23	Pl 15 mo	No	Aguirre	20 70	18 41		89 00	
				Tns Cane per acre					
PR 219	3 21 24	Pl 19 mo	No	Hatillo	42 45	18 47		91 20	
Rayada	3 21 24	Pl 19 mo	No	Hatillo	22 20	16 51		91 00	
PR-219	12 9 24	Pl 9 mo	No	Hatillo		11 78		77 17	

(1) Second in tons cane out of 47 kinds
(2) Third in sucrose out of 40 kinds to date

* PR–230.

Parentage unknown, but probably seedling of D–117.

Erect or at length decumbent, vigorous, good stooler, arrows

freely. Stalks medium length and diameter, green then yellow, little or no flush, no bloom. Internodes medium to long, at first cylindrical then tumid on side behind the bud, somewhat staggered, furrow usually none. Nodes slightly constricted, somewhat oblique; growth ring broad, often 3 or more mm., somewhat elevated, brownish; root band 8 to 10 mm., somewhat constricted, nearly concolorous; rudimentary roots large, crowded, yellowish brown, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, 6 to 7 mm., slightly constricted, well defined. Buds ovate, obtuse, at first about 10 × 10 mm., often soon expanding, usually purplish, exceeding the growth ring, margin rather broad, uniform germination subapical, basal placs short and scanty, margins nearly glabrate, a scanty apical tuft from behind the bud. Leaf sheaths at first with a moderate vestiture, becoming glabrate, green, somewhat glaucous; throat lannate, with a sparse vestiture of short hairs on the margins and behind the ligule; collar narrow, reaching the midrib, glaucous or the margins slightly lannate; ligule about 3 mm., the margin fimbriate and ciliate; ligular processes usually one moderately developed. Leaf blades suberect, the tips declined, flat, about 6 to 7 cm. wide, bright green, minutely serrulate, the base even and slightly ciliate.

This cane somewhat closely resembles D-117 but the foliage is lighter in color, the buds are more nearly glabrate and the collar is less lannate.

It is a rather promising cane, especially for the red shale hills, where it ratoons strongly. It does not mature quite as early as Cristalina, but may be used for either fall or spring planting.

It has good resistance to root disease, as shown by its good ratooning power. Its resistance to mosaic and gum disease has not been determined.

Its record for sucrose follows:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-280	4-25-13	Pl.	......	....	15.8	12.42	....	78.6	....
P R-280 (1) ...	5-4-16	....	......	....	20.5	17.04	....	83.12	....
P R-280	4-25-17	....	......	....	22.51	20.70	....	91.96	....
P R-280	April, 1918	Pl. 11 mo..	......	....	21.50	19.10	....	88 88	....
P R-280	4-28-19	Rat. 12 mo..	......	59.0	20.50	18.38	....	89.65	....
P R-280	1-13-20	Rat. 8 mo..	......	64.91	17.80	15.00	....	84.55	....
Cristalina ...	1-13-20	Rat. 8 mo..	......	....	....	16.35	....	....	....
P R-280	April, 1920	Rat. 11 mo..	......	61.90	22.01	20.23	....	91.91	....
P R-280	12-8-20	Rat. 10 mo..	No..	75.0	12.53	8.02	3.65	64.0	9.0
Rayada	12-8-20	Rat. 10 mo..	No..	71.1	15.88	13.45	1.76	84.96	8.08
P R-280	1-21-21	Pl. 15 mo..	Yes.	67.2	18.30	15.38	1.81	84.04	12.46
Cristalina ...	1-21-21	Pl. 15 mo..	No..	70.0	17.25	15.96	0.87	92.52	9.60
P R-280	2-14-21	Pl. 16 mo..	No..	69.5	17.85	15.58	1.07	86.79	12.20
Rayada	2-14-21	Pl. 16 mo..	No..	68.6	17.15	15.25	0.81	88.92	12.97
P R-280	1-17-23	Pl. 18 mo..	No..	Aguirre	22.00	19.41	....	88.30	....
P R-280	2-23-23	Pl. 14 mo..	No..	Aguirre	20.20	17.19	....	85.00	....
P R-280	12-22-24	Pl. 17 mo..	No..	Aguirre	18.20	16.36	....	89.70	....
P R-280	12-23-24	Pl. 16 mo..	No..	Aguirre	18.40	16.46	....	89.50	....

(1) Third in tons cane out of 47 kinds.

The figures would indicate, as Earle remarks in his Aguirre notes, that this variety is worth further trial. We have it planted out in tonnage experiments at the Station in comparison with the other P.R. seedlings and B.H.–10(12) and it is looking very well at present.

* **PR–260.** See Plate V, opposite page 239.

Parentage unknown:

Erect, vigorous, medium stooling, arrows freely. Stalks long, medium diameter, green, then yellow, with a faint flush, medium heavy bloom. Internodes medium to long, cylindrical, slightly staggered, furrow usually evident for full length of internode. Nodes scarcely constricted, somewhat oblique; growth ring narrow, even, concolorous; root band 8 to 10 mm., concolorous; rudimentary roots large, indistinct, in about 3 rows; leaf-scar glabrous, constricted behind. Buds narrowly ovate, acute, about 10 $\times$ 14 mm., but often soon considerably elongated, exceeding the growth ring by one-third to one-half, margin medium width, uniform, germination apical, basal placs heavy with a conspicuous tuft on shoulders, margin glabrate, but sparse, apical tuft. Leaf sheaths with a heavy stiff vestiture, green, a little glaucous, stained with purple at base within; throat lannate, with a vestiture of rather short hairs on the margins; collar reaching the midrib, lannate; ligule about 3 mm., fimbriate; ligular processes one usually developed, about 14 mm., obtuse. Leaf blades erect except the tips, flat, about 7 cm. wide, medium green, minutely but sharply serrulate, the base not ciliate.

This is one of the best canes in this series. It does fairly well on hills but is best on rich *vega* land. It matures rather late and so is best planted in the fall. On suitable soils it gives a very heavy tonnage and ratoons well. Its planting was at one time considerably extended in the Guánica district.

In the Santa Rita immunity experiment it proved to be rather unusually resistant to mosaic and its seedlings, a number of which have been grown at the Mayagüez Station, seem to quite uniformly inherit this characteristic. The writer has seen it heavily infected with gum disease.

In a variety test on rich cow-penned land at Central Mercedita, Yabucoa, it made the highest tonnage of any cane tested. Cut February, 1920, as plant cane at 17 months, it gave: tons cane per acre, 78.82; brix, 14.55; sucrose, 11.18; purity, 76.7; tons sugar per acre,

6.313. Clearly this cane was still green or the yield of sugar would have been much higher. Other analyses follow:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-260..........	4-24-12	Pl..............	......	....	18.2	17.7	....	96.8	....
P R-260..........	5-4-16	....	......	....	18.5	17.68	....	95.56	....
P R-260..........	4-25-17	....	......	....	20.61	18.50	....	89.75	....
P R-260..........	2-12-17	Pl..............	......	....	17.70	14.72	....	83.22	....
P R-260..........	2-1-18	Rat. 12 mo....	......	....	14.60	12.50	....	85.61	....
P R-260..........	12-6-20	Rat. 10 mo....	......	78.0	14.43	10.52	2.85	72.90	7.56
Cristalina	12-6-20	Rat. 10 mo..	......	78 0	15.63	13.61	1.78	85.76	10.80
P R-260..........	12-22-20	Rat. 14 mo....	No..	69.2	15.40	12.45	1.47	80.84	12.44
P R-260..........	12-22-20	Rat. 14 mo....	Yes.	65 0	17.00	14.81	0.61	87.11	14.00
Cristalina	12-22-20	Rat. 14 mo....	No..	70.8	17.85	16.14	0.33	90.42	10.69
P R-260..........	1-21-21	Pl. 15 mo....	Yes.	67.2	18.10	15.50	0.77	85.63	11.80
Cristalina	1-21-21	Pl. 15 mo....	No..	70.0	17.25	15.96	0.37	92.52	9.60
P R-260..........	2-23-21	Pl. 16 mo....	No..	64.2	17.86	15.90	0.62	89.07	12.58
P R-260..........	2-23-21	Pl. 16 mo....	Yes.	65.1	17.95	15.78	0.75	87.47	12.96
Rayada..........	2-23-21	Pl. 16 mo....	No..	63.6	17.15	15.25	0.81	88.92	12.67
P R-260..........	5-3-21	Pl. 18 mo....	Yes.	66.1	19.70	18.13	0.233	92.36	... .
P R-260...... ...	1-18-22	Pl. 13 mo....	Yes.	....	18.25	14.28	... .	78.30	....
P R-260..........	2-20-23	Pl. 14 mo....	Yes.	... .	17.70	13.55	....	76.50	....
P R-260..........	3-21-23	Pl. 15 mo....	Yes.	....	20.90	18.92	....	90.50	....
P R-260..........	12-2-24	Pl. 16 mo.. .	Yes.	....	16.50	13.67	....	82.90	....
P R-260..........	12-16-24	Pl. 17 mo....	Yes.	....	17.60	15.32	....	87.10	....

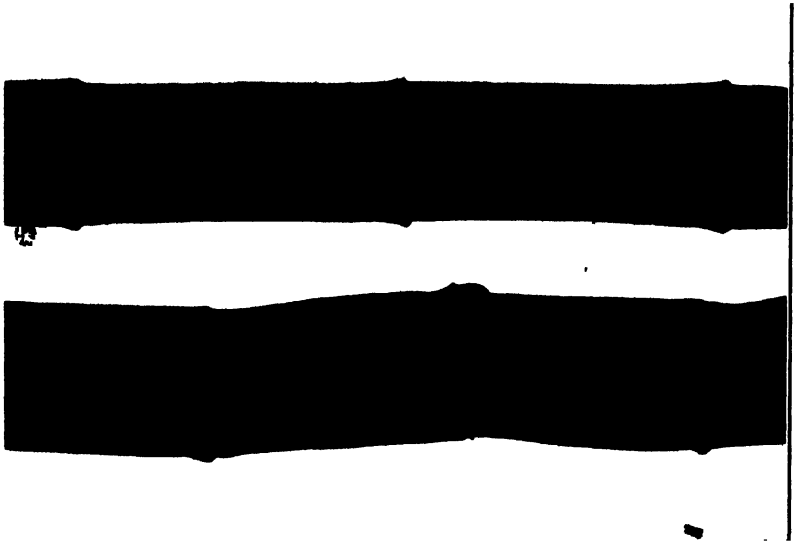
Earle found at Aguirre that it germinated poorly in most plantings and in tonnage experiments on rather poor *vega* land at the Station it has uniformly ratooned poorly. Foss finds it in general "above the average" in Aguirre.

* PR-270.

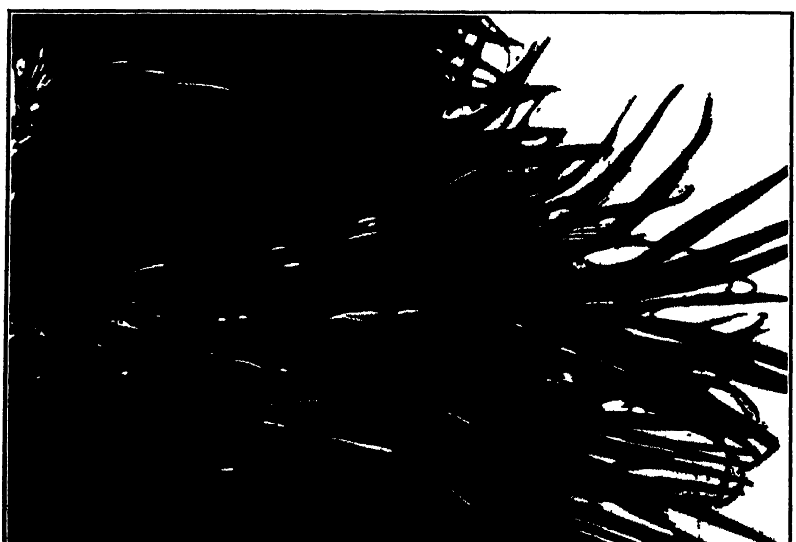
Parentage unknown.

Soon decumbent and prostrate, vigorous, medium stooler, arrows frequently. Stalks long, medium diameter, bright green, sometimes with pink flush, no bloom. Internodes medium length, cylindrical, somewhat staggered, furrow none or evident only on the lower internodes. Nodes scarcely constricted, oblique; growth ring broad but indistinct, even, concolorous; root band 8 to 10 mm., concolorous; rudimentary roots crowded, pallid, in 3 or 4 rows; leaf scar glabrous, narrow, appressed behind; glaucous band wide, 10 mm., slightly constricted, well defined. Buds oval, 7 to 10 $\times$ 8 to 12 mm., not exceeding the growth ring, margin rather broad, uniform, germination subapical or subdorsal, basal places short, margins nearly glabrate but with a few scattered hairs, a sparse apical tuft from behind the bud. Leaf sheaths with heavy stiff vestiture, green, scarcely glaucous; throat densely lannate and with scanty marginal vestiture; collar reaching the midrib, glaucous, the margins lannate; ligule short, 2 or 3 mm., even; ligular processes when present reduced to a blunt lateral protuberance. Leaf blades erect except the tips, somewhat plicate and inrolled, 7 to 7½ cm., sharply serrulate to the base not ciliate.

PLATE XXVI



P. R. 27



P. R. 358

This is a good vigorous cane, but with nothing to particularly recommend it. It is rather late in maturing. In the immunity tests at Santa Rita it made a poor showing, being badly injured by root disease and top rot and suffering seriously from mosaic.

It develops good sucrose but only when fully mature:

Kind	Date	Age	Arr.	Extr.	Brix	Sucr.	R. S.	Purity	Fiber
P R-270........	4-24-18	Pl..............	......	....	19.3	17.28	....	89.5	.....
P R-270........	5-4-16	....	.....	....	18.2	16.44	....	90.33	....
P R-270........	4-25-17	....	......	....	22.20	20.50	....	92.34	....
P R-270........	April, 1918	Pl. 11 mo....	......	....	18.65	15.59	....	83.59	....
P R-270........	4-28-19	Rat. 12 mo....	......	58.00	20.00	18.25	....	91.25	....
P R-270........	1-14-20	Rat. 12 mo....	......	68.04	15.72	13.31	....	84.66	....
Cristalina.....	1-14-20	Rat. 12 mo....	......	60.22	17.46	15.93	....	91.23	....
P R-270........	4-5-20	Pl. 18 mo....	......	60.00	21.39	19.35	....	90.46	....
Rayada........	12-10-20	Rat. 10 mo....	No..	71.10	15.83	13.45	1.76	84.96	8.08
P R-270........	12-10-20	Rat. 10 mo....	No..	69.00	14.33	10.69	3.00	74.59	7.44
P R-270........	2-2-21	Rat. 10 mo....	No..	67.80	17.40	14.97	1.19	86.03	12.42
P R-270........	2-2-21	Rat. 10 mo....	Yes.	70.90	17.55	15.20	0.95	86 60	12.80
P R-270........	2-28-21	Pl. 16 mo....	No..	61.9	17.75	15.98	0.62	90.02	12.22
P R-270........	2-28-21	Pl. 16 mo...	Yes.	66.6	17.20	16.56	0 64	96.14	12.48
Rayada........	2-28-21	Pl. 16 mo....	No..	68.6	17.15	15 26	0.81	81.92	12.87

* PR-271. See Plate XXVI, opposite page 249.

Parentage unknown.

Erect or at length declined, vigorous, moderate stooling, arrows frequently. Stalks long, medium to medium stout, green then yellow, often a slight purplish flush, heavy bloom. Internodes medium length, cylindrical, staggered, furrow usually none. Nodes scarcely constricted, somewhat oblique; growth ring rather broad but indistinct, greenish or brownish; root band narrow, 6 to 8 mm., concolorous; rudimentary roots large but indistinct, in 2 or 3 rows; leaf scar glabrous, narrow, appressed behind; glaucous band broad, 10 to 12 mm., very slightly constricted, not well defined. Buds triangular, ovate, 12 to 12 × 11 to 12 mm., slightly exceeding the growth ring, margin rather broad, a little wider below but not shouldered, germination apical or subapical, heavy basal placs, moderate marginal vestiture extending well up on sides of bud and conspicuous apical tuft. Leaf sheaths with dense harsh vestiture, green a little glaucous; throat densely lannate, and with a heavy vestiture of medium short hairs on the margins and behind the ligule; collar reaching the midrib, lannate; ligule about 3 mm., even; ligular processes usually none. Leaf blades erect almost to the tips, somewhat plicate, two-ranked, broad, 8 or 9 cm., sharply serrulate to the base, not ciliate.

This is one of the best general-purpose canes in this series but it is a little late in maturing and so should be used for fall planting. It succeeds well on either high or low land.

It is known to be attacked by mosaic, but it was not included in the Santa Rita experiment, so its disease resistance has not been fully tested.

When immature it is very low in sucrose but develops a good percentage at maturity.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-271	4-25-13	Pl	....	....	19.50	17.91	....	91.8	....
PR-271	5-4-16	....	....	....	20.50	19.52	....	95.21	....
PR-271	4-25-17	....	....	....	22.85	21.00	....	91.90	....
PR-271	4-5-18	Pl. 11 mo.	....	....	20.15	17.83	....	88.48	....
PR-271	4-29-19	Rat. 12 mo.	....	58.2	20.30	18.47	....	91.0	....
PR-271	1-13-20	Rat. 8 mo.	....	63.46	....	13.50	....	88.88	....
Cristalina	1-13-20	Rat. 8 mo.	....	....	16.19	16.35	....	....	....
PR-271	Apr. 1919	Rat. 11 mo.	....	66.66	20.44	18 67	....	91.63	....
PR-271	2-28-20	Pl. 16 mo.	No	71.60	18.55	16.62	0.65	91.21	12.49
Rayada	2-28-20	Pl. 16 mo.	No	63.60	17 15	15.27	0.81	88.92	12.57
PR-271	5-4-21	Pl. 18 mo.	Yes	67 2	19.60	18.30	0.475	93.36	....
PR-271	1-18-23	Pl. 13 mo.	No	....	19.60	17.18	....	87.40	....
PR-271	2-23-23	Pl. 14 mo.	No	....	21.15	18.17	....	88.70	....
PR-271	3-20-23	Pl. 15 mo.	No	....	19 70	17.44	....	88.50	....
PR-271	4-16-23	Pl. 16 mo.	No	....	19.55	18.07	....	92 40	....

This cane gives good tonnage, keeps remarkably well in the field and is one of the most generally promising canes in this series. For this reason it is hard to understand it having disappeared from the Station when the writer arrived here in 1923. He obtained seed from W. C. Dreier, of the Hatillo Fruit Co. Farm on the Trujillo Alto Road near the Station, where it has been giving excellent results for years, and it is now planted out in tonnage experiments with the remaining P.R. seedlings and with B.H.–10(12) for a check. It is looking very well indeed at present.

* **PR–272.**

Parentage unknown.

Erect or at length decumbent, moderate vigor and stooling, seldom arrows. Stalks medium length and diameter green or yellowish, usually with pink flush, no bloom. Internodes medium length, cylindrical or somewhat larger below, straight, furrow none. Nodes scarcely constricted, nearly rectangular; growth ring 2 or 3 mm., usually elevated, rather inconspicuous; root band about 8 mm., the base constricted, tapering downward, concolorous, rudimentary roots large, whitish, in 2 or 3 rows; leaf scar at first somewhat ciliate below the bud, then glabrate, appressed behind; glaucous band about 6 mm., poorly defined. Buds broadly oval, usually reddish, about 9 $\times$ 10 mm., not exceeding the growth ring, margin narrow, uniform, germination subdorsal, almost glabrate, basal placs greatly reduced and very scanty marginal vestiture. Leaf sheaths with vestiture of soft hairs, at length often nearly glabrate, green but somewhat tinted, somewhat glaucous, hanging long on the stalk; slightly stained purple at base within; throat lannate and with an abundant vestiture of hairs on margins and behind ligule; collar broad, deeply wrinkled, reaching

the midrib, glaucous or slightly lannate on margins; ligule abruptly widened at center, reaching 5 mm., fimbriate and ciliate; ligular processes on one side only, short, obtuse. Leaf blades spreading, strongly revolute, about 7 cm., light green, minutely serrulate, the base not ciliate.

This cane is not desirable for general planting, since it is lacking in vigor on poor hill lands. It is adapted to moist *vegas*. It ripens fairly early and develpos high sucrose at full maturity. Its disease resistance has not been fully tested.

It made a good record in the rich cow-penned land in the variety tests at Centrad Mercedita, Yabucoa, where, cut in February, 1920, as plant cane at 16 months, it gave: tons cane, 59.46; brix, 14.90; sucrose, 12.81; purity, 85.3. It was evidently not fully matured, since, as seen in the following analyses, the sucrose should go much higher:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S	Purity	Fiber
P R-272	4-24-18	Pl.	...	...	18.6	17.05	...	91 6	...
P R-272	5-4-16	...	...	...	21.8	20 97	...	98.45	...
P R-272	4-25-17	...	...	...	22 58	20.50	...	90.79	...
P R-272	2-4-18	Pl.	...	...	12.87	10.00	...	77.70	...
P R-272	1-7-20	Rat. 14 mo.	...	56.61	17.07	14.76	...	86.46	...
P R-272	12-18-20	Rat. 10 mo.	...	71.1	15.48	12 84	1.74	81.20	9.24
Cristalina	12-18-20	Rat. 10 mo.	No	...	...	13.41	1.78	85.76	10.80
P R-272	12 18-20	Rat. 14 mo.	No	69.1	17 50	15 17	1 01	86.86	9 88
Cristalina	12-18-20	Rat. 14 mo.	No	70 0	17.50	15.58	0 28	88.74	9 60
P R-272	2-28-21	Pl. 16 mo.	No	66.6	19 90	18.84	0 72	92.16	11.85
Rayada	2-28-21	Pl 16 mo.	No	68.6	17.15	15.25	0.81	78.92	12 47
P R-272	5-4-21	Pl. 18 mo.	No	60.9	20.55	18 35	0.265	93.91	...
P R-272	1-18-28	Pl. 18 mo.	No	...	19 70	16.79	...	85 20	...
P R-272	2-20-28	Pl. 14 mo.	No	...	19 60	14.95	...	76 80	...
P R-272	3-21-28	Pl. 15 mo.	No	...	20.90	18.86	...	90 20	...

Earle remarks in his Aguirre notes, from which the last series of analyses is taken, that the variety has no value there and our experience here at the Station has led us to the conclusion that this classification would apply to it under most conditions, hence we have ceased to experiment with it at the Station. Planted at the Station in a plat with P.R.–270, 292 and 358, it was definitely inferior to the other three in development and general stooling. This plat was planted in the fall of 1924 and no further plantings of this variety have since been made.

* **PR–292.** See Plate V, opposite page 239.

Parent, D–117.

Erect, or at length somewhat declined, vigorous, good stooler, arrows, freely. Stalks long, medium diameter, green with strong red flush, heavy bloom. Internodes long, enlarged below, staggered, furrow none. Nodes constricted, oblique; growth ring about 2 mm., brownish, somewhat elevated; root band 6 to 8 mm., tapering down-

wards, the base constricted, concolorous; rudimentary roots obscure, in about 3 rows; leaf scar glabrous, narrow, not much compressed behind; glaucous band constricted, 8 to 10 mm. wide, poorly defined. Buds broadly triangular-ovate but seeming obovate from the flaring margin, about 11 × 10 mm., scarcely exceeding the growth ring, margin, about 10 × 10 mm., scarcely exceeding the growth ring, margin very wide and with long shoulders almost to the emerginate tip, germination subapical, basal places scanty but extending half way up on the shoulders, marginal vestiture above the places very scanty, apex glabrous. Leaf sheaths with short appressed vestiture, green, somewhat tinted, slightly glaucous, stained with purple at the base within; throat densely lannate and with vestiture of rather short hairs on the margins and behind the ligule; collar reaching the midrib, glaucous, the margins minutely lannate; ligule short, about 2 mm., fimbriate; ligular processes reduced to a scarcely noticeable lateral protuberance on one side. Leaf blades erect except the tips, somewhat plicate, or nearly flat, 7 or 8 cm. wide, dark green, minutely serrulate, the base even, sometimes slightly ciliate.

This is a good general-purpose cane. It can be especially recommended for the red shale hills, where it gives heavy tonnage and ratoons remarkably well. It does not ripen quite as early as Cristalina, still it may be used for either fall or spring planting. It arrows too freely to be held over as long crop or *caña quedada.*

It made a good record in the Santa Rita immunity tests, being rather more resistant than Rayada to both root disease and mosaic. It has not been tested for gum disease.

Kind	Date	Age	Arr.	Extr.	Brix	Sucr.	R S.	Purity	Fiber
PR-292	4-23-18	Pl	.. ..	....	17.94	15.70	... ...	87.5	.. ....
PR-292.....	5-5-16	... .	. ....	.. ..	19.10	16 70	....	86 91	.. ...
PR-292.....	4-25-17	. .. .	....	....	22.55	21.50	. . ..	95.34	.. ....
PR-292. ...	2-4-18	Pl	....	.. ..	16.50	14 10	.. ...	85,4	....
PR-292. ...	1-18-20	Rat. 14 mo ...	....	59.49	15.32	12.96	. ....	84 59	....
PR-292.....	12-10-20	Rat. 10 mo. ..	No	72 70	15.23	12.10	2.47	79.44	8.78
Rayada ...	12-10-20	Rat. 10 mo....	No	71 10	15.83	13 45	1 76	84 96	8.06
PR-292.....	12-18-20	Rat. 14 mo....	No	67.20	16.63	14 3	0.86	85.86	9.84
PR-292. ..	12-18-20	Rat. 14 mo ...	Yes	65.60	17.08	14 79	0 63	86.86	11.69
Cristalina .	12-18-20	Rat. 14 mo....	No	70.00	17.50	15.:5	0.28	88.74	9.60
PR-292....	2-7-21	Pl. 16 mo. ..	No	66.6	18.50	16.8	0.65	90.81	... .
PR-298.....	2-7-21	Pl. 16 mo.....	Yes	61.9	18.20	16.45	0.55	90 38	12.95
PR-292. .	2-7-21	Pl. 16 mo....	No	68.6	17.90	16 14	0.808	90.16	13.81
Cristalina .	2-28-21	Pl 16 mo. ..	No	69.4	19.60	18 11	0 41	92.59	12.24
PR-292. ..	2-28-21	Pl. 16 mo ...	Yes	67.9	19.25	17 28	0.49	89 76	12 84
PR-292. ..	2-28-21	Pl 16 mo....	No	68.6	17.15	15.25	0.81	88.92	12.87
Rayada....	5-4-21	Pl. 18 mo .	No	60 0	19.20	17 97	0 289	93.95	.. ....
PR-292....	5-4-21	Pl. 18 mo. ..	Yes	72.4	20.00	18 57	0.601	92.85	....
P R-292 ..	1-18-23	Pl. 12 mo. ...	No	Aguirre	17 95	14.99	....	83 50	....
P R-292 ..	2-20-23	Pl. 14 mo.	No	Aguirre	18 60	16 58	....	89 20	.. ....
P R-292 ...	3-21-23	Pl. 15 mo. ...	No	Aguirre	18.90	14 91	....	79.00	....
P R-292	4-16-23	Pl. 16 mo.	No	Aguirre	17.85	13.36	... .	74.90	....
				Tns. Cane per acre		Tns. Sugar per acre			
P R-292....	3-21-24	Pl. 22 mo. .	No	14.82	Hatillo	15 87	1.71	87.10	....
Rayada....	3-21-24	Pl. 22 mo.	No	6.56	Hatillo	16.67	0.80	88.20	....

Certainly worthy of further, trial and has been planted out at the Station in tonnage plats in comparison with the other P.R. canes and with B.H.–10(12) for a check. At present is looking exceptionally well. Earle reports it as susceptible to *Phyllosticta sacchari* leaf spot (det. Matz) in Aguirre.

* PR–308.

Parents unknown.

Erect or at length procumbent, good vigor and stooling, arrows occasionally. Stalks long, medium diameter, green with a strong reddish flush, little bloom. Internodes medium length, conspicuously enlarged below, only slightly staggered, furrow usually none. Nodes scarcely constricted, oblique; growth ring broad, 2 to 4 mm., elevated but with a depressed line in center, dark green; root band strongly oblique, 6 to 10 mm. tapering downward the base constricted, concolorous; rudimentary roots large but inconspicuous, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band 8 or 9 mm., not constricted, well defined. Buds broadly ovate or semi-orbicular but a little broader than long, about 12 × 10 mm., scarcely exceeding the growth ring, margin broad, broader below but hardly shouldered, germination subdorsal, basal placs short, with a scanty marginal but usually rather pronounced apical vestiture. Leaf sheaths with a heavy vestiture of long, coarse hairs, green or slightly tinted, glaucous, stained with purple at base within; throat densely lannate, extending in lines up the base of the leaf blade, and with an abundant vestiture of medium short hairs on the margins and behind the ligule; collar narrow reaching the midrib, glaucous, the margins heavily lannate; ligule short, 2 or 3 mm., the margin jagged and somewhat ciliate; ligular processes one usually developed but small and obtuse. Leaf blades erect except the tips, somewhat plicate and revolute, broad, 8 or 9 cm., dark green, sharply serrulate to the base, not ciliate.

This is a good vigorous high-tonnage cane, but it should only be planted in low lands. It does not do well on the red shale hills. It is rather late in ripening, so is best planted in the fall, but it may be planted in the spring if not cut under 12 or 13 months. It can be carried over successfully for long crop, or *caña quedada*, as it keeps well in the field and is not much eaten by rats. Its disease resistance has not been fully tested.

It is low in sucrose when green but develops a good percentage at full maturity. The last analysis given for 1921 was the highest sucrose found in any variety so far that year.

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-308	4-22-18	Pl	....	....	18 9	17.41	....	92.1	....
PR-308	5-5-16	....	....	....	21.5	20 00	......	93.02	....
PR-308	1-25-17	....	....	.. ..	20 75	19.50	....	91.56	....
PR-308	Apr. 1918	Pl. 11 mo.	....	....	16.40	13.01	......	79.32	....
PR-308	6 1-18	Pl. 18 mo.	....	... .	18.90	17.06	....	93 12	....
PR-308	4-29-19	Rat. 11 mo ...	....	58.9	19.70	18.21	....	92.43	....
PR-308	1-8-20	Rat. 14 mo....	.. ....	62 92	17.42	15 15	. .....	86.96	....
PR-308 .	Apr. 1920	Rat 11 mo....	.. ...	63.46	20.81	18 96	....	88 92	... .
PR-308	1-8-20	Rat. 8 mo ...	....	65.85	18.89	9.71	. . ...	86.90	....
PR-308	12-13-20	Rat. 10 mo....	....	75 0	18.73	11.88	3 15	82.95	9.00
Rayada....	12-13-20	Rat. 10 mo....	No	71 1	15.83	13 45	1.76	84.96	8.06
PR-308 . .	2-28-21	Pl 16 mo.	No	70 3	17 90	15 80	0 88	88 26	12.84
Rayada....	2-28-21	Pl 16 mo.....	No	68.6	17 15	15 25	0.81	88.92	12.37
PR-308	5-5-21	Pl. 18 mo. ...	No	60 7	21 0	19 94	0.191	94.95	....
PR-308 ..	6-7-24	Pl. 11 mo.....	No	Hatillo	19 60	17.66	0 97	90 10	....
BH (12)....	6-7-24	Pl 11 mo ...	No	Hatillo	19 20	16.82	0 80	87.60	....
PR-308	6-7-24	Rat 11 mo ..	No	Hatillo	19 40	17 39	0.67	89.63	....
PR-308	6-7-24	Pl 21 mo. ..	No	Hatillo	21.50	19 45	0.46	90 47	....
PR-308 ...	3-2-25	Pl. 20 mo ...	No	Hatillo	17 65	15 22	0.57	89.27	....
BH 10 (12)	3-2 25	Pl 20 mo ...	No	Hatillo	17.70	15 98	1.18	90 00	....
PR 308 ..	5-14-26	Pl. 14 mo. ...	No	Hatillo	20 00	18.28	0 19	91 15	....
BH 10 (12)	5-14-26	Pl 14 mo ..	No	Hatillo	18 8	16 80	0.35	89 12	....
				Tns. Cane per acre		Tns Sugar per acre			
PR-308	5-14-26	Pl 14 mo. ..	No	28 7	Hatillo	17 15	3 07	80.00	....
BH 10 (12)	5-14-26	Pl 14 mo	No	21.8	Hatillo	17.90	2 92	89.86	....

This is quite a good record and it is being further tried.

* PR-309.

Parent unknown.

Erect, then declined, vigorous, medium stooler, seldom arrows. Stalks long, medium diameter, bright green, sometimes with a pink flush, no bloom. Internodes medium length, larger below, somewhat staggered, furrow slight and poorly defined or none. Nodes prominent, not constricted, nearly rectangular; growth ring about 2 mm., enlarged, the thickest part of the stalk, concolorous or brownish; root band 8 to 10 mm., tapering downward, concolorous; rudimentary roots large, distant, in about 3 rows; leaf scar at first lannate below the bud, appressed behind; glaucous band about 6 to 8 mm. tapering downward. Buds, oval, small, about 8 × 9 mm., not exceeding the root band, margin narrow, uniform, germination dorsal or subdorsal, nearly glabrous, basal placs greatly reduced but extending well up on the sides. Leaf sheaths with a dense vestiture of long stiff, assurgent hairs, green or tinted, slightly glaucous, stained with purple at base within; throat densely lannate and with an abundant vestiture of medium long hairs on margins and behind ligule; collar narrow, reaching the midrib, lannate; ligule narrow, 2 or 3 mm., entire; ligular processes none. Leaf blades erect except the tips, flat, about 7 cm., dark green, minutely serrulate, the base nearly even, not ciliate.

A vigorous cane of high tonnage but best adapted to low lands.

It is late in maturing and should only be planted in the fall. Its disease resistance has not been determined.

Its late maturity is indicated by the following analyses.

It should be tested for long crop or *caña quedada:*

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
PR-309........	4-25-15	Pl.	....	....	15.5	12.61	.... ..	81.3	... ...
PR-309........	5-5-16	....	....	....	17 0	14.60	....	85 88	... .
PR-309........	4-26-17	.. .. ..	......	... ..	18.55	16 00	....	86 25	....
PR-309........	4-15-18	Pl 11 mo .	.. ....	. .	16 85	13 12	... ..	77 81	.... .
PR 309........	4-30-19	Rat. 12 mo...	.. ....	57.6	17.90	15 30	... ..	85 47	....
PR-309	4-15-20	Rat 11 mo...	... .	71.42	17 59	14 51	....	82.49	. ....
PR-309 (1). ...	1-3-20	Rat. 14 mo ..	.. ...	66.03	13 05	9.24		70 80	....
PR-309.	12-13-20	Rat 10 mo...	..	72.40	15.09	11 93	2.15	79 05	7.72
Rayada........	12-13-20	Rat 10 mo..	No ..	71 10	15.83	13 45	1 76	84 96	8 06
PR-309.. .. .	2-28-21	Pl. 16 mo ..	No ..	65 80	20.60	19 41	0.72	94 22	12 49
Rayada	2-28-21	Pl 16 mo ...	No ..	63 60	17 15	15.25	0 81	88.92	12.87

(1) *Lowest in sucrose out of 87 kinds*

* PR-317.

Parents unknown.

Erect, at length declined, vigorous, good stooler, arrows frequently. Stalks long, medium diameter, green then yellowish with a reddish flush, little or no bloom. Internodes long, at first cylindrical, then somewhat ventricose on side opposite bud, somewhat staggered, furrow usually evident. Nodes somewhat constricted, more or less oblique; growth ring poorly defined, about 2 mm., concolorous or dull brownish; root band 9 to 12 mm., concolorous; rudimentary roots small, crowded, in 4 to 6 rows; leaf scar glabrous, appressed behind; glaucous band broad, 10 to 12 mm. somewhat constricted. Buds large, flat, narrowly ovate, pointed but not acute, about 12 × 15 mm., exceeding growth ring by one-third to one-half; margin broad, uniform, germination apical, basal places well developed and extending up onto shoulders, marginal vestiture scanty. Leaf sheaths with a dense, coarse, strongly assurgent vestiture, green or tinted, glaucous, stained with purple at the base within; throat lannate and with a rather scanty vestiture of medium short hairs on the margins and behind the ligule; collar reaching the midrib, glaucous, the margins lannate; ligule rather narrow, abruptly widened to 4 mm., at center, minutely fimbriate; ligular processes one usually developed, small, obtuse. Leaf blades erect except the tips, somewhat plicate and revolute, about 7 cm. wide, minutely serrulate, the base even, not ciliate.

A sport with pink stripes was found by Earle and cultivated as X-64.

In the Santa Rita immunity experiment it proved more resistant than Rayada to root disease, but rather more susceptible to mosaic. It has not been tested for gum disease.

In the variety test on rich cow-penned land at Central Mercedita, Yabucoa, it made a good record, cut February, 1920, as plant cane of 17 months: tons cane per acre, 54.87; brix, 16.10; sucrose, 13.12; purity, 81.5; tons sugar, 5.089.

Kind	Date	Age	Arr	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-317	4-24-13	Pl.			17.6	15 10		85.8	
P R-317	5-5-16				18 1	15.61		86 24	
P R-317	1-15-17				20 05	18.40		91 77	
P R-317	2-12-18	Pl 15 mo.			11.70	8 21		70.12	
P R-317	1-7-20	Rat. 14 mo		61.58	17.17	14.76		85 96	
Cristalina	1-7-20	Rat 16 mo.				17 27			
P R-317	12-13-20	Rat. 10 mo.	No	72.10	13.48	9 15	2.01	72.5	9.08
Cristalina	12-13-20	Rat. 10 mo.	No			13.41	1.73	85 76	10 80
P R-317	12-22-20	Rat 14 mo.	No	65 80	15 60	12 89	1.74	82 62	9 36
P R-317	12-22-20	Rat. 14 mo	Yes.	74 0	16 23	13 65	1 81	84.10	11.62
Cristalina	12-22-20	Rat. 14 mo	No	70 0	17 50	15 53	0.28	88.70	9.60
P R-317	3-3-21	Pl. 16 mo	No	71 4	16 85	13.35	1.04	79.22	11 44
Rayada	3-3-21	Pl. 16 mo	No	72 7	18 25	16.30	0 71	89 31	12.00
P R-317	5-5-21	Pl. 18 mo.	No	64 5	20.00	18 81	0.488	94.60	
P R-317	1-18 23	Pl. 13 mo.	No		17 30	13 90		80 40	
317	2-20 23	Pl. 14 mo.	No		16 10	11 66		72 40	
317	3 21-23	Pl. 15 mo.	No		16 60	12.32		74 30	

The last series of analyses is copied from Earle's Aguirre notes on this kind, where he decided it was of no value. The same conclusion is merited at the Station, where experiments with it have been discontinued.

* PR-318.

Parents unknown.

Erect, at length declined, medium vigor and stooling, seldom arrows. Stalks medium stout, green then yellowish with a purplish-red flush, considerable bloom. Internodes medium to short, somewhat barrel shaped, staggered, furrow usually none. Nodes constricted, somewhat oblique; growth ring about 2 mm., usually a little elevated, yellowish brown then dark green; root band 6 to 9 mm., constricted, green; rudimentary roots medium size, crowded, greenish; leaf scar glabrous, appressed behind; glaucous band 10 mm., slightly constricted, well defined. Buds triangular-ovate, obtuse, often reddish, about 12 × 12 mm., slightly exceeding the growth ring, margin medium width, broader below but scarcely shouldered, germination subapical, basal placs well developed and extending up onto the shoulders, marginal and apical vestiture scanty. Leaf sheaths glabrous or nearly so, green or tinted, somewhat glaucous, stained with purple at base within; throat densely lannate and with abundant vestiture on margins and behind ligule; densely lannate throughout; ligule about 3 mm., fimbriate; ligular processes usually one developed, short, 6 to 8 mm., obtuse. Leaf blades erect except the tips, flat, broad, 8 to 9 cm., serrulate to the base, not ciliate.

In the Santa Rita immunity experiment its record was fair, being a little better than Rayada as regards root disease and about the same in susceptibility to mosaic. It has not been tested for gum disease.

In the variety tests on cow-penned land at Central Mercedita, Yabucoa, it gave the poorest tonnage out of the eight kinds tested; tons cane per acre, 30.73; brix, 17.10; sucrose, 13.74; purity, 82.6:

Kind	Date	Age	Arr.	Extr.	Brix.	Sucr.	R. S.	Purity	Fiber
P R-318	4-25-18	Pl.			19.4	17 64		90.9	
P R-318	5-5-16				18 7	17 02		91.01	
P R-318	4-25-17				22 15	20.60		93.00	
P R-318 (1)	2-12-18	Pl. 16 mo.			19.70	17.80		90 31	
P R-318	12-18-20	Rat 10 mo.	No.	71.1	15.66	12.22	2.32	78.03	8.09
Rayada	12-18-20	Rat. 10 mo.	No.	71.1	15 83	13.45	1.76	84 96	8.08
P R-318	12-22-20	Rat. 14 mo.	No.	69.0	17.78	15 85	0.84	89.39	12 40
Cristalina	12-22-20	Rat. 14 mo.	No.	70.0	17.50	15.58	0 28	88.74	9.60
P R-318	1-26-21	Rat. 15 mo.	No.	70.5	17.95	15.85	0.78	88.30	12.98
Cristalina	1-26-21	Rat. 15 mo.	No.	70.3	17.85	16.14	0.38	90 42	10.69
P R-318	5-5-21	Pl.	No.	67.1	19.10	17.73	0.70	92.82	

(1) First in sucrose out of 20 kinds.

Planted out at the Station in the fall of 1924, in comparison with P.R.–270, 292 and 358, it made such an inferior showing to these kinds in germination, stooling, girth and general development that it was decided by Mr. Luis Serrano, the Assistant Agronomist, and the author, to definitely abandon this variety in further experiments.

The Porto Rico Seedlings Produced in 1913

* **PR–328.** See Plate V, opposite page 239.

Seedling of B–3412.

Erect, later semi-recumbent, good vigor, fair stooler, arrows early and freely. Stalks long, medium girth, dark pink, changing to red on exposure, heavy bloom. Internodes long, cylindrical, with a decided shoulder on side opposite bud, slightly staggered, furrow distinct, narrow and flat. Nodes prominently enlarged, at right angle to stalk; growth ring broad, 6–10 mm., very prominently elevated, brown; root band parallel, light green, changing to pinkish on exposure; rudimentary roots not crowded, purple, 2–4 in rows; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds large, about 14 by 16 mm., suborbicular, barely exceeding growth ring, margins broad and uniform, germination apical, light basal plaos, neither marginal vestiture nor conspicuous apical tuft. Leaf sheaths with dense vestiture along back, sides glabrate, greenish or slightly tinted, somewhat glaucous, inner base heavily stained with purple; throat lannate and with an abundant vestiture of long hairs; collar

medium width, reaching midrib, glaucous; ligule 3 by 6 mm., nearly even; ligular process none. Leaf blades erect with declining tips, flat, 7 by 9 cms., dark green, minutely and uniformly serrulated, no basal ciliation.

One of the more promisıng of this series of canes. The following analyses of it have been made:

ANALYSES IN THE INSULAR STATION

Analyses in the Insular Station								
Plant	IX 13 14	Brix	20 42,	Suc	18 65,	Puri	91 88	(laborat)
	IV 5 16		20 8		18 75		90 14	
	IV 25 19		17 63		14 87		84 05	(Central)
	V 27 18		19 71		18 20		92 84	(laborat)
Second in sucrose of 20 var Cristalina first								
III 18-21	(18 mos)	Brix	20 80	Suc,	18 84,	Puri	90 84	(laborat)
	Cristalina		21 18		19 44		91 78	(laborat)
8 mos ratoons I 10 20	Extr 66 20		17 86		14 68		85 56	(laborat.)
	Cristalina		16 81					(laborat)
Ratoons 11 mos Mar 1920	69 28		19 79		17 89		87 87	(laborat)
Third in suc 7th in Pur of 15 var								
V 13 20	64 66		21 65		17 70		81 71	(laborat)
	Cristalina				20 46		90 85	(laborat)
Plant 12 mos April, 1920	66 66		20 12		18 28		90 60	(laborat)
9th in Suc 11th in Pur of 25 var								
10 mos May 8 21	64 7		16 80		13 68		81 42	(laborat)
Cristalina	70 5		18 00		16 28		90 44	(laborat)
11 mos IV 1 21	78 2		19 25		16 30		84 67	(laborat)
Cristalina	69 2		18 30		17 15		98 71	(laborat)
Analyses in Central Aguirre Plant								
	I 16 28		20 80		17 78		87 6	(laborat)
	II 20 3		19 60		17 04		87 0	(laborat)
	III 23 23		20 90		18 76		89 7	(laborat)
	IV-16 28		18 85		14 59		77 4	(laborat)
Analyses of plant in Insular Station								
IV-5 22	69 28		19 94		18 61		93 88	(laborat)
Cristalina	63 63		18 61		17 22		92 50	(laborat)

Tonnage Expt at Station ground at Central Vannina

G C 18 mos II-9-26 53 15 Tns Cane p a Brix 16 80 Suc 13 40 Purity 82 20 Tns Sug p a 4 83
B H 10 (12) —II 9 26 54 81 Tns Cane p a, Brix 17 48 Suc 15 00 Purity 86 06 Tns Sug p a 6 05

In the tonnage test in comparison with B.H.–10(12) and fourteen others of our most promising canes, P.R –328 stood seventh in sucrose content and fifth ın productıon of sugar per acre, being passed in the latter respect only by P.R.–460, B.H.–10(12), Badilla and D–1135.

PR–329.

Seedlings of B–3412. One of the dwarf type of cane, producing heavy tonnage and having good sugar content. Evidently a *vega* cane. Is a good ratooner. Earle considers it of no value on the South Coast.

Erect, good vigor, fair stooler, arrows fairly freely. Stalks long, stout, yellowish green changing to red and then to purplish brown abundant bloom when young. Internodes short, cylindrical, in

straight line; furrows distinct but very shallow. Nodes even, at right angle to stalk; growth ring medium width, even, greenish brown, becoming concolorous with age; root band parallel, 6–10 mm., concolorous; rudimentary roots few and scattered, 2–3 in rows, concolorous; leaf scar ciliated, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds large, 14 × 18 mm., lanceolate, exceeding growth ring by one-half, heavy marginal vestiture of long hairs, distinct apical tuft, germination apical, heavy basal placs. Leaf sheaths with light vestiture at back, sides glabrate, greenish and slightly tinted, glaucous, inner base lightly stained with purple; throat lannate, with short appressed hairs; collar wide reaching midrib, lannate; ligule about 4 mm. wide, nearly even; ligular process small, broad and inconspicuous, on one side only. Leaf blades spreading with tips well declined, flat, 8–10 cms., wide, dark green, distinctly striated, very minutely but uniformly serrulated at margins, long straggling hairs at base.

The following analyses have been made:

Age	Date	Brix.	Suc.	Pur.	Mill.	Extrac.	
Plant	IX-18-14	19.42	17.55	90.87	Lab		
	IV-5-16	19.50	17 51	89.76	Lab.		
	IV-5 19	16 10	14 12	86 09	Cent.	58 8	
....	V-27-18	19 02	17 80	90 96	Lab		(3rd in Suc of 20 Var.)
1st. Ratoons.	III 20	19 79	17.27	87 26	Lab.	68 0	(4th. in Suc. of 15 Var.)
....	V-18-20	20.15	17.85	86 10	Lab	58 78	(18 mos)
Cristalina......	... .		20 46	90 85	Lab.		
Plant	IV-20	20.62	18 40	89 · 8	Lab	71 05	(12 mos) 8th of 25 Var.
....	V-20	17 15	18 68	79.76	Lab.	71 10	(10 mos.) Fibre 11.6
Cristalina.	....	18 00	16 28	90.44	Lab.	70 50	10.6
Plant	IV-25-21	16 55	13.44	81.20	Lab.	62 20	(11 mos.) 12 1
Cristalina.......	....	18 80	17.15	93.71	Lab.	69 20	12.3

Plant in Central Aguirre, 1923

	I-18	19 80	16.59	85.50	Lab		Earle states that this variety
	II-28	18 30	15 51	84 90	Lab		is probably of no value on
	III-21	18 20	15.65	86.00	Lab.		South Coast
Plant	IV-5-22	20 41	18 40	90 15	Lab.	71 77	Red Sug 1.079
Cristalina		18 61	17.22	92 50	Lab.	68 68	0.697

Tonnage Experiment at Insular Experiment Station

G. C. 16 mos.—II-9-26—40.50 tons cane per acre (Stood 10th out of 16 varieties)
BH–10(1)—II–9–26—54.81 tons cane per acre. (Stood 4th out of 16 varieties)

Striped Sports of PR*329.

Mr. Luis Serrano has found and bred true to type in the station two distinct stripped sports of P.R.–329, one a green stripe on a red ground and the other a yellow stripe on the red ground. In everything but color these sports are typical of the P.R.–329, but comparative experiments with them should be carried on to determine if their chemical qualities may or may not have changed with their color mutation.

PR–358. See Plate V, opposite page 239; also Plate XXVI, opposite page 249.

Seedling of Trinidad 77. It is remarkable that a variety of such distinct parentage could be so similar to P.R.–328. Earle considers that it has no value on the South Coast. It suffers considerably from the root disease complex.

Erect, at length recumbent, good vigor, fair stooler, arrows freely. Stalks long, medium girth, dark pink changing to red on exposure, heavy bloom. Internodes long, cylindrical, lower joints inclined to tumidity with occasional shoulder at bottom end opposite but, slightly staggered; furrow distinct, medium width and shallow. Nodes constricted, at right angle to stalk; growth ring broad, very prominently elevated brown; root band parallel, 6–10 mm., light green changing to purplish on exposure; rudimentary roots fairly crowded, 3–4 in rows, purple; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds large, about 12 × 16 mms., lanceolate, exceeding growth ring by one-third, heavy marginal vestiture of long hairs, germination apical, heavy basal placs. Leaf sheaths with light vestiture of long hairs at back, sides glabrate, greenish or slightly tinted; slightly glaucous base and heavily stained with purple within; throat with short appressed hairs, broad and well defined; collar medium width, reaching midrib, covered with short wooly hairs; ligule 3–6 mms., nearly even; ligular process none. Leaf blades erect with declining tips, flat, wide, 8–10 cms., dark green, minutely and uniformly serrulated, margins near base with long straggling hairs.

The following analyses have been made:

Location	Date	Age.	Mill	Tns cane per acre	Brix.	Sucr.	Purity	Remarks
Ins. Expt. Sta	5-27 18	Plant. .	Hand	... .	18 27	16.00	87 02	9th of 20 var.
Ins Expt Sta.	1-10 20	Rat 8 mo	Hand	.. ..	16 06	12 56	78 20	12th of 17 var.
Ins Expt Sta	3 14 21	18 mos	Hand		18 45	16 08	86.87	Fiber 12 60
Cristalina..	3-14-21	18 mos	Hand	.	21 18	19 44	91 78	Fiber 18 00
Ins. Expt Sta	Mar 1920	Rat 11 ms	Hand	. ...	18 22	16 79	92 1[illegible]	6th in suc of 15 v.
Ins Expt Sta.	5-18-20	Rat 18 ms	Hand	..... .	20 35	17 00	83 98	... .
Cristalina	5-18-20	Pl 18 mos.	Hand	.. ..	..	20 46	90 85	....
Ins Expt Sta.	Apr., 20	Pl. 18 mos.	Hand	.... ..	19 01	17.30	91 00	16th in suc. of 20 v.
Ins. Expt Sta	3-29-21	Pl 10 mos.	Hand	. . ..	17 65	15 90	90.08	Fiber 11-56
Cristalina.	3-28-21	Pl 10 mos	Hand	... ...	18.00	16 28	90.44	Fiber 10-62
Ins Expt Sta	4-25-21	Pl. 11 mos.	Hand	.. .. .	18.45	14 47	89 21	Fiber 12-58
Cristalina . ..	4-25 21	Pl. 11 mos.	Hand	.. ....	18 30	17.15	93 71	Fiber 12-82
Cent Aguirre..	1-18-23	Pl 13 mos.	Hand	... .	18.15	14.76	81 30	....
Cent. Aguirre .	2-23-23	Pl 14 mos.	Hand	... .	18.10	14.53	80,40	Sound and ripe
Cent. Aguirre..	3 21-23	Pl. 15 mos.	Hand	....	17.40	14 25	81 90	Mostly roten
Ins Expt. Sta.	4-5-22	Pl. 12 mos.	Hand	....	19 01	17 01	89.47	Gluc 0 906
Cristalina.. .	4-5-22	Pl 12 mos.	Hanh	....	18 61	17.22	92,50	Gluc 0.632
Ins. Expt. Sta.	2-9-26	Pl 16 mos.	Cent.	61.48	12 15	8.69	71.52	3.50 tns. sug. per a.
B. H. 10 (12)...	2-9-26	Pl. 16 mos.	Cent.	54 81	17.48	15.00	86.06	6 05 tns. sug. per a.

A variety of very little promise indeed.

PR-383.

A cross between Otaheite and *D-117*. Shows the latter parentage very strongly. The author, upon his arrival at the Station in 1923, found that the stand of this variety had been lost, but was able to secure some seed from Mr. W. C. Dreier, manager of the Hatillo Fruit Co., along with P.R.-208, 308, 472 and 502. Of all of these the P.R.-383 germinated the worst and in general it is not a promising looking cane.

Recumbent, fair vigor, good stooler, very susceptible to mosaic. Stalks long and fair girth, green to yellow, no flush no bloom. Internodes medium to long, cylindrical, not staggered, furrow traces to none. Nodes oblique, nearly even; growth ring narrow, 2-4 mms., inconspicuous, even, concolorous; root band narrow, oblique, concolorous; rudimentary roots small, numerous and scattered, 3-5 in rows, concolorous; leaf scar glabrate and appressed behind; glaucous band broad, slightly constricted and conspicuous. Buds small to medium size, 6-8 mms., not exceeding growth ring, suborbicular, germination apical, margins very narrow and scantly lannated, shouldering at base, light basal places, decided tendency to premature sprouting. Leaf sheaths with scanty dorsal vestiture of white hairs, sides glabrate, green with inner base tinted, glaucous; throat broad, well defined, lannate with short appressed hairs and few long straggling hairs at margins; collar very broad and dark, reaching midrib, glaucous; ligule narrow, 2-4 mms. at sides, but abruptly enlarged at center, where lower margin is concave and upper even; ligular process similar to that of its parent, D-117, long and on one side only. Leaf blades spreading with declining tips, medium width, about 6 cms., light green, uniformly serrated and ciliated at base.

The following few analyses are on record at the Station:

Age	Extract.	Brix	Sucrose	Glucose	Purity	Fiber	Date
18 mths..................	70 5	18.75	16.87	1 29	87.80	11.80	III-14-21
Cristalina	67.5	21.18	19.44	0 40	91.78	13.00	III-14-21
19 mths..................	60.0	20.10	18.57	0.55	92 38	12 80	IV-27-21
17 mths..................	66.6	19.29	17 40	0.51	90 20	....	V-9-21
12 mths..................	70.78	18.51	16.73	....	91.19	....	April, 1920

(In this test, 18th in sucrose out of 25 varieties.)

THE PORTO RICO SEEDLINGS PRODUCED IN 1914

PR-417.

Parentage unknown. Agricultural Agent J. Quiñones Ruiz wrote us from Jayuya under date of 23rd February, 1924:

"PR-417 germinates later than B-3412, but is more resistant to mosaic disease, although we have rogued it also and there are some infected stools still. It is a poor ratooner."

Here at the Station it has shown a fair tonnage and holds its condition well once it has matured. Subinspector of Agriculture Rafael Bermúdez reports, in Circular 7 of the Department of Agriculture, a yield of 20 tons per acre from this cane at Guayama, cut at seven months for seed, in comparison with 30 tons for B-3412. It does not give much promise, although Bermúdez reports it resistant to borer.

Erect, at length recumbent, good vigor, arrows freely. Stalks long, medium diameter, basic color yellowish green, becoming reddish tint to dirty purple, very slight bloom. Internodes medium length, constricted and broad at base, very slightly staggered, furrow occasional or none. Nodes constricted, at right angle to stalks; growth ring wide and prominent, yellowish brown changing to purple; root band parallel, wide, 6–10 mms., light yellow changing to dark green and purple; rudimentary roots inconspicuous, few and scattered, 2–3 in rows, concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds small, 10 × 14 mms., scarcely exceeding growth ring, margins glabrate, suborbicular, glabrate and fairly wide, no apical tuft, germination apical, light basal place. Leaf sheaths with abundant dorsal vestiture, sides glabrate, purple, glaucous, heavy coating of wax, heavily stained with purple within; throat lannate, long tufts at margins; collar wide, reaching midrib, glaucous; ligule narrow, 2–4 mms., nearly even; ligular process none. Leaf blades erect with declining tips, flat, rather narrow, 5–7 cms., midrib purplish, rest of leaf light green with occasional purple shading, margins minutely and uniformly serrulated, long, straggling hairs at base.

The following analyses have been made, all but the last two being from juices extracted in laboratory mills. The penultimate analysis is from cane ground at Central Triunfo and the last at Central Vannina.

ANALYSES IN INSULAR EXPERIMENTAL STATION PLANT

Date	Brix	Sucr.	Purity	Extr.	Gluc.	Fibre
VI-1-15	17.40	15.26	87.70	....	....	....
V-8-16	20.00	18.04	90 20	....	....	....
IV-24-19	18.60	16.60	89.24	55 0	....	....
III-18-21	19.20	16.75	82.08	67.7	1.060	9.44 (18 mos.)
Cristalina	21.18	19.44	91.78	67.5	0.898	13.00
V-9-21	19.09	16.72	87 58	68.7	1.060	(17 mos.)
XI-1-20	19.55	17.39	88.95	65.5	0.870	12.02 (13 mos.)
Cristalina	19.30	18.23	94.92	68.9	0.197	11.55
VI-5-20	18.89	16.51	87.40	50 0	(19th in Sucr. and Pur. of 25 vs.)	
V-18-20	19.92	17.55	88.10	60.00		
IV-27-21	17.30	12.69	78 85	61.9	2.990	12.19 (11 mos.)
Cristalina	18.30	17.15	93.71	69 2	0.290	12.32

ANALYSES IN CENTRAL AGUIRRE PLANT

Date	Brix	Sucr.	Purity	
I-8-23	18.65	15.86	85 10	(12 mths.)
II-23 23	19.60	16.69	85.10	(14 mths)
III-21-23	20.30	18.07	88 90	(15 mths.)
1925	17.6	15.30	86.94	(Reported by Agr. Agt Diaz, without age)
V-27-26	18.95	16.70	88 10	(13 mo rat.) Gave 28.4 tons. cane per acre
B-3412	16 05	12 72	79.25	(12 mo. rat) Gave 21.0 tons. cane per acre

PR–422.

Parents unknown. An exceptionally good germinater, which is resisting very unfavorable hillside conditions at the Hatillo Fruit Company Farm near the Station, being far ahead of PR–328 and 358 in this respect.

Erect, fair vigor, arrows early and prolifically. Stalks long, medium diameter, yellow, almost no bloom. Internodes medium length, cylindrical to slightly tumid, very slightly staggered, no furrow. Nodes slightly constricted at base, at right angle to stalk; growth ring wide and prominent, red becoming concolorous with age; root band oblique, medium width, 5–8 mms., narrowing towards back, concolorous; rudimentary roots inconspicuous, few and scattered, 2–4 in rows, concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds large, 12 × 16 mms., exceeding growth ring by one-third, suborbicular, wide margins with heavy vestiture and distinct apical tuft of long hairs, germination apical, basal place covered with short, wooly hairs. Leaf sheaths lannate abundantly at back, sides glabrate, green with purple margins at sides and base, glaucous, stained with red at base within; throat lannate, with long straggling hairs; collar medium width, reaching midrib and of distinct dark gray color, glaucous; ligule narrow, 2–4 mms., nearly even; ligular process none. Leaf blades spreading and rather erect

tips, flat, medium width, 6–8 cms. dark green, margins minutely but distinctly serrulated, ciliated near base.

The following analyses of juices obtained through the laboratory mill at the Station have been made, all but the last one being from Station plats. The last analysis is from nine-months plant cane sent from the Hatillo Fruit Co. Farm:

Date	Age	Tns Cane p. acre	Extra.	Brix	Sucr.	Gluc.	Purity
V-27-18	Plant	15.12		19.47	17.20		88.34
IV-8-21	17 mo.		60.8	19.85	18.18	0.482	91.84
I-12-20	R. 8 mo.		47.8	18 31	15.94		87.05
Mar., 20	R. 11 mo.		55 6	19 92	17.92		89 95
V-18-20	R. 13 mo.		55 6	21.65	19.81		91.50
Cristalina	R. 13 mo				20 46		90.85
XII-11-20	9 mo.			15.15	11.64		76.83

PR-430.

Parents unknown. Earle reports it from Aguirre as of no value and thinks it should be exterminated.

Erect, at length recumbent, very good vigor, good stooler, arrows early and prolifically. Stalks long, rather slender, green, some bloom. Internodes long, larger below, shouldered at base opposite bud, decided tendency to split, very distinctly staggered, furrow trace to none. Nodes constricted, oblique; growth ring wide and prominent, brown changing to concolorous; root band oblique, wide, 6–10 mms., yellow to green; rudimentary roots inconspicuous, few and scattered, 2–3 in rows, concolorous; leaf scar glabrous, broad and prominent in front and appressed behind; glaucous band constricted and well defined. Buds rather large, at first not exceeding growth ring but later extending, broadly ovate, germination apical; narrow margins with little vestiture, inconspicuous basal placs. Leaf sheaths with scanty vestiture of short hairs at back, sides glabrate, green, glaucous; throat lannate, with long straggling hairs; collar wide, reaching midrib, distinct dark gray color, glaucous; ligule narrow, 2–4 mms., nearly even; ligular process none. Leaf blades spreading with declining tips, wide, 10–12 cms., dark green, margins hardly serrulated, almost glabrate at base.

The following analyses have been made, all but the last two being from cane grown on Station or Aguirre plats and ground in the laboratory mill. The last two analyses are of comercial quantities of cane from the Hatillo Fruit Co. Farm near the Station, ground at Central Victoria, Carolina.

Date	Age	Location	Extrac.	Brix	Sucr.	Gluco.	Purity	Tns. Cane p. Acre
V-27-18	Plant	Ins. Sta.	...	16.96	14.80	...	87 26	...
III-21-21	18 mo.	Ins. Sta	68 70	18 50	15 87	1 65	85.78	Fib -11 26
Cristalina	18 mo.	Ins. Sta	67 50	21.18	19 44	0 40	91 78	Fib.-18.00
V-10-21	17 mo.	Ins. Sta.	62 00	17.69	15 12	1 18	86.08	...
I-12-20	R 8 mo	Ins Sta	68 00	15.09	11.98	...	79 06	...
Mar., 20	R 11 mo	Ins Sta.	67 81	18 62	16.47	...	88 45	...
V-18-20	R 18 mo	Ins. Sta	62 50	20.45	17 61	...	86.06	...
Cristalina	R 18 mo	Ins Sta	...	...	20 46	...	90 85	...
Apr 20	P 12 mo	Ins. Sta.	56 52	20 08	17 85	...	88.62	...
III-28-21	10 mo.	Ins Sta.	61.40	16.70	12.20	11.58	73.05	Fib -12.85
Cristalina	10 mo.	Ins Sta	70 50	18 00	16.28	0 65	90 44	Fib -10.62
IV-26-21	11 mo	Ins Sta.	67.10	16 80	18 49	1 68	80 28	Fib -11.86
Cristalina	11 mo	Ins. Sta.	69.20	18 80	17 15	2 90	93.71	Fib.-12 82
I-18-23	18 mo.	Aguirre	...	16.20	12 88		76.10	...
IV-6-22	12 mo.	Ins. Sta	70 86	16 78	18 74	1.77	82.12	...
Cristalina	12 mo.	Ins Sta.	66 68	18 61	17.22	0 70	92.50	...
III-21-24	19 mo.	Hatillo	...		16.04		86.10	34.5
Rayada	19 mo.	Hatillo	...	...	16.51		91.00	22.2

PR-431.

Parentage unknown.

Recumbent, good vigor, fair stooler. Stalks long, medium diameter, pinkish red, heavy bloom. Internodes medium length, slightly tumid, slightly staggered, furrow traces to none. Nodes constricted, oblique; growth ring wide and prominent, narrowing towards front, yellowish green; root band parallel, wide, 5–9 mms., yellow changing to purple; rudimentary roots inconspicuous, few and scattered, 3-4 in rows, light purple to concolorous; leaf scar glabrous and appressed; glaucous band constricted and fairly well defined. Buds medium size, scarcely exceeding growth ring, orbicular, germination subapical, narrow margins covered with very short appressed hairs, apical tufts of very short hairs, inconspicuous basal placs of short white hairs. Leaf sheaths with scanty vestiture of short hairs at back, sides glabrate, green changing to purple on lower leaves, glaucous; throat lannate with abundant long hairs; collar wide, reaching midrib, glaucous; ligule narrow, 2–4 mms., nearly even; short ligular process, 1–2 cms., on one side only. Leaf blades spreading with declining tips, narrow, 4–6 cms., light green, tendency to purplish tint in midribs, margins ciliated and minutely but uniformly serrulated, base provided with long straggling hairs.

The following analyses have been made from extractions in Station laboratory mill. All samples except the last, which is from Hatillo Fruit Farm, are from Stations plats:

Date	Age	Extra.	Brix	Sucr.	Gluc.	Purity	Fiber
V-10-21	17 mo.	60 0	17.18	15.20	0.984	88.78	...
I-12-20	R 8 mo	60 9	15.56	12.52	...	80.46	...
Mar., 20	R 11 mo	60.5	17.58	15.64	...	88 96	...
V-18-20	R 11 mo	64.0	21.35	19.14	...	89.64	...
V-18-20	R 11 mo	...	...	20.46	...	90.85	...
IV-28-24	3rd Rat.	59.8	17.65	15.58	...	88.27	...
...	21 mths	...	...	...	...	...	...

PR-433. See Plate V, opposite page 289.

Parentage unknown. Very similar in general appearance to PR-492, but lacks the long apical tuft on bud of latter. This is one of the most promising of the Porto Rican seedlings. At the Station it has done consistently well and plantings out on the Island have generally shown up good. On a visit with Mr. R. Menéndez Ramos, formerly Director of the Station, to the *finca* of Don Paco Solá in October, 1924, this variety was amongst the best of those growing on a patch of poor hillside land, which lot included SC-12/4, BH-10(12), D-1135, etc.

Erect, good vigor, good stooler, early and heavy arrower. Stalks long, medium girth, green changing to yellow, no flush, some bloom. Internodes of medium length and width, slightly tumid at base opposite bud, at right angles to stalks; furrow very broad and shallow. Nodes even and parallel; growth ring narrow but prominent, red to concolorous; root band parallel, wide, 6-10 mms., concolorous; rudimentary roots inconspicuous but crowded, 3-4 in rows, concolorous; leaf scar glabrous, broad and prominent in front and appressed behind; glaucous band constricted and conspicuous: Buds rather large, exceeding growth ring, ovate to suborbicular, germination apical; wide margins covered with short, appressed hairs, light apical tuft of short hairs; inconspicuous basal placs Leaf sheaths glabrate, green tinted with purple; inner base heavily stained with purple; sheath slightly glaucous; throat lannate, with long tufts of hairs; collar broad, reaching midrib, glaucous; ligule rather wide, 3-5 mms., nearly even; ligular process none. Leaf blades spreading with declining tips, rather narrow, 5-6 cms., light green, margins minutely and uniformly serrulated, base slightly ciliated.

In December, 1924, on a gently sloping hillside of red clay at the Hatillo Fruit Farm, it was as first ratoons, the outstandingly best of some ten varieties, mostly Porto Rico seedlings. While PR-333 had been superior as plant cane, PR-433 passed it as first ratoons. Mr. Brebner, Agriculturist at Central Aguirre, reported to the writer a yield of 65 tons per acre from this variety early in January, 1925. Rafael Bermúdez, Subinspector of Agriculture at Guayama, reports in Circular 7 of the local Department of Agriculture that it was one of the best of the Porto Rico seedlings tried out there. He said:

"Although its tonnage yield was a bit low, compared with the other varieties, it is one of the most promising canes on account of its closing quickly and its excellent general development. Another advantage of this variety is that the leaves drop as soon as they are dry. This characteristic makes its harvesting more economical."

The following analyses have been made:

Location	Date	Age	Mill	Tns Cane p. acre	Brix	Sucr.	Purity	Remarks
Ins. Sta.	V-27-18	Plant	Lab.	14 14	15.55	11.20	72.02	18th out of 20
Ins. Sta.	III-18-21	18 mos	Lab.	Fib. 11 81	20.91	19 87	92 15	Glucose 0.457
Cristalina	III-18-21	18 mos	Lab.	Fib 18 00	21.18	19.44	91.78	Glucose 0 398
Ins. Sta.	Apr, 1920	12 mos	Lab	...	21 18	19.64	92.12	2nd out of 25
Ins. Sta.	V-18-20	18 mos	Lab.	...	21.92	19 90	90 81	...
Ins. Sta	III-28-21	10 mos	Lab.	Fib. 12 42	18 70	16.49	90 58	Glucose 0.65
Cristalina	III-28-21	10 mos.	Lab.	Fib. 10 62	18 00	16 28	90 44	Glucose 0 65
Ins. Sta.	IV-27-21	11 mos	Lab	Fib 18.22	18 90	16.98	89.84	Glucose 1.01
Cristalina	IV-27-21	11 mos	Lab	Fib. 12 82	18.80	17.15	98 71	Glucose 2 90
Ins. Sta	IV-5-22	12 mos	Lab.	...	18 84	17 80	91.80	Glucose 0 59
Cristalina	IV-5-22	12 mos	Lab.	...	18 61	17.22	92 50	Glucose 0 70
Ins. Sta.	IV-8-22	12 mos	Lab.	...	16 79	14 49	86 30	Glucose 1.48
Hat. Fruit.	VI-7-24	11 mos	Lab	...	17 20	14 58	84 87	Glucose 1 85
B H. 10 (12)	VI-7-24	11 mos	Lab	...	19 20	16 82	87 60	Glucose 0 80
Hat. Fruit	VI-7-24	R-11 mos	Lab	..	22.50	20 47	90 97	Glucose 0.60
Hat. Fruit	VI-7-24	R-21 mos	Lab.	...	20 80	18 21	89.70	Glucose 0.98
Ins Sta	X-28-24	P-10 mos	Lab	...	15 40	11 52	74 81	...
Hat. Fruit	IV-28-24	R-21 mos	Lab	...	17 75	15 48	87 21	...
Ins Sta	V-10-21	P-17 mos	Lab	...	18 88	17.91	94 91	Glucose 0 89
Aguirre	I-2-25	11½ mos	Cent	85 0	18 10	15 42	85 20	T. sug. p. a. 7.88
Hat. Fruit	II-3-25	20 mos	Lab	8th of 17 v	17 88	15 64	90.25	...
B.H. 10 (12)	II-3-25	20 mos	Lab	6th of 17 v	17 70	15 98	90 00	...
Cambalache	III-14-24	12 mos	Lab	44 12	.	16 87	91 19	...
S C. 124	III-14-24	12 mos	Lab	42 85		15 94	90 10	...
Hat Fruit	V-14-26	14 mos	Lab.	...	20 80	18 69	92 07	Glucose 0 27
B.H. 10 (12)	V-14-26	14 mos	Lab	...	18 85	16 80	89.12	Glucose 0 85
Hat. Fruit.	V-14-26	17 mos	Cent	15 00		18 52	91.50	T sug p a. 2 11
B H. 10 (12)	V-14-26	17 mos	Cent	21 80	.	17 90	89 86	T. sug. p a. 2.92

PR-440.

Parents unknown. A very vigorous cane of rather doubtful maturing qualities. Earle considers it of doubtful value for South Coast. Mr. Mateo Fajardo, Jr., of Central Eureka, on the West Coast, reported to the writer on 3rd March, 1924, that it had done very well there. It is a splendid germinator everywhere.

Recumbent, splendid vigor, good stooler, early and prolific arrower Stalks long, medium diameter, dark purplish red, considerable bloom. Internodes of medium length, tumid, staggered; furrow none. Nodes even; growth ring broad and prominent, narrowing on convex side of curve as cane bends upwards from reclining position, concolorous; root band oblique, wide, 6–10 mms., narrowing towards back, yellowish green to concolorous; rudimentary roots inconspicuous, scattered, 3–4 in rows, concolorous; leaf scar glabrous, broad and prominent in front and appressed behind; glaucous band conspicuously sunken. Buds large, exceeding growth ring by one-third, lanceolate, germination subapical, wide, flat margins covered with short appressed hairs, abruptly shouldered at base; no apical tuft; heavy basal place. Leaf sheaths with scanty vestiture of short hairs at back, sides glabrate, purple; inner base lightly tinted, somewhat glaucous; throat lannate with short wooly hairs and long tufts at margins; collar broad and well defined, reaching midrib and of distinct brown color, lannate, with extremely short wooly hairs; ligule rather wide, 3–5 mms.,

nearly even; ligular process none. Leaf blades spreading with declining tips, rather broad, 7–9 cms., distinctly striated, tendency to purple midrib, margins almost even at base, but minutely serrulated towards tips, slightly ciliated at base.

The following analyses have been made (laboratory mill):

Location	Date	Age	Extrac.	Brix	Sucr.	Purity	Fiber
Ins. Sta.	III-18-21	18 mos	67.8	15.40	10.91	70.84	11.59
Cristalina	III-18-21	16 mos	67.5	21.15	19.44	91.78	13.00
Ins Sta	V-10-21	17 mos	64.0	15.58	11.78	75.58	..
Ins. Sta.	IV-20-21	18 mos	71.4	17.30	15.18	87.74	11.44
Cristalina	IV-20-21	18 mos	68.9	19.80	18.88	94.92	11.55
Ins Sta.	III-28-21	10 mos	70.8	16.80	13.18	78.45	11.86
Cristalina	III-28-21	10 mos	70.5	18.00	16.28	90.44	10.62
Ins. Sta	IV-97-21	11 mos	64.0	16.70	12.74	76.28	12.96
Cristalina	IV-27-21	11 mos	69.2	18.30	17.15	93.71	12.22
Aguirre	XXI-18-23	18 mos	...	20.50	17.47	85.20	...
Aguirre	II-24-23	14 mos	...	17.65	13.52	76.70	...
Aguirre	III-21-23	15 mos	...	16.90	13.20	78.10	...
Aguirre.	XI-28-24	16 mos	...	14.70	11.54	78.50	...
Aguirre	XII-12-24	17 mos	...	14.70	11.30	76.90	...
Ins. Sta.	IV-5-22	12 mos	...	16.38	12.88	78.56	...
Cristalina	IV-5-22	12 mos.	...	18.61	17.22	92.50	...
Hatillo Fruit	IV-28-24	R. 19 mos	56.8	15.70	13.50	85.98	...

Practically all of this long series of analyses show disastrously low sugar contents and purities and it is unfortunate that a cane with such a poor record should have become rather widely distributed over the Island merely on account of its very vigorous growth. Certain centrals are even now multiplying this variety rather extensively on the basis of its tonnage yield of cane alone and it appears to the writer that they will be rudely awakened to the low sugar yield of this cane onece they have gone to the heavy expense of planting it in large areas. It is certainly not a cane to be recommended.

PR-460.

Parents unknown. An exceptionally fine-looking cane on good *vega* lands.

Recumbent, good vigor, fair stooler, arrows early and abundantly. Stalks long, rather slender, pale purple, abundant bloom, red flush. Internodes long, slightly tumid, perpendicular to stalk, with decided tendency to split; furrow wide and shallow. Nodes nearly even; growth ring broad and prominent, parallel, yellowish green becoming concolorous; root band wide, 6–10 mms., parallel, concolorous; rudimentary roots conspicuous, scattered, 3–5 in rows, purplish; leaf scar glabrate, appressed behind, glaucous band constricted and well defined. Buds large, exceeding growth ring by one-third, ovate to lanceolate, germination apical, very narrow glabrate margins, no

basal place. Leaf sheaths glabrate, purplish, slightly glaucous; inner base lightly tinted; throat lannate, with short appressed hairs and long tufts at margins; collar wide and well defined, reaching midrib, glabrate and glaucous; ligule wide; 4–6 mms., nearly even, ligular process none. Leaf blades spreading with declining tips, broad, 10 by 12 cms., distinctly and uniformly serrated, a few long hairs at base.

The following analyses have been made:

ANALYSES IN THE INSULAR EXPERIMENTAL STATION PLANT

Date	Brix	Sucrose	Purity	Extract	Glucose	Fiber	Age
VI-1-15	18.80	15 90	88 88				
V-8-16	18 70	16 49	88.18				
IV-8-19	20.00	18.05	90.08	57.8			
V-10 21	17 66	15 51	88 39	60 6	898		17 months
V-10-21	16.96	14 78	87 14	62 5	949		17 months
III-18-21	19 60	17 51	89 38	66 6	.394	12.02	18 months
Cristalina	21 18	19.44	91 78	67 5	.398	13 00	
IV-20-21	18 95	16 83	88.65	65 7	.380	12.34	18 months
Cristalina	19 30	18.38	94.92	68 9	.197	11 55	
IV-20	19 59	17.44	89 02	55.6 (15th in suc., 14th in P. of 25)			
V-18-20	20 62	18 64	90.39	61.58			
III-28-21	17 30	14 85	85 83	66 10	850	13 56	10 months
Cristalina	18.00	16 28	90 41	70 50	650	10 62	
IV-27-21	18.00	15.82	87 88	61 20	.986	12.41	11 months
Cristalina	18.30	17.15	93.71	69.20	290	12.82	
III-8-22	16.89	14 25	84.37	65.04	.742 (Cristalina 18.61 sucrose)		

ANALYSES IN CENTRAL AGUIRRE PLANT

Date	Brix	Sucrose	Purity
I-18-23	18 80	15.41	82.00
II-24-23	18.30	14.58	79.50

ANALYSES AT HATILLO FRUIT CO. RIO PIEDRAS
Planted in August 1922; harvested at 19 months

III-21-24		15.68	89.40	Rend. 11.47 42 tons. cane per acre
Rayada		16.51	91.00	12.28 22.2 tons. cane per acre

Barahona	III-1-25	Plant cut for seed at 8 mos Rend 28 tons cane per acre (Anglereau)
B-H. 10(1)	III-1-25	Plant cut for seed at 8 mos. Rend 26 tons cane per acre (Anglereau)
Guayama	II-6-25	Plant cut for seed at 8 mos. Rend 24 tons cane per acre (Bermúdez)
Naguabo	V-20-25	Plant cut for seed at 8 mos Rend 30 tons cane per acre (Miguel Díaz)
Ins. Sta.	II-9-26	15.14 11.96 79.00 Rend 71.60 tons cane and 6.28 tons sug. p. a. G C. at 16 mos.
B-H. 10(12)	II-9-26	17.48 15 00 86.06 Rend 54 81 tons cane and 6 05 tons sug p. a. G. C. at 16 mos.
Ins. Sta.	V-27-26	19 30 16.79 87.00 Rend 28.40 tons cane per acre as 18-month ratoons
H. 109	V-27-26	18.35 16 70 88.10 Rend 25.00 tons cane per acre as 12-month ratoons

PR–472.

Parentage unknown. When the writer arrived at the Insular Station in 1923, he found that the stand of this good-looking cane had been lost and managed to obtain some seed from Mr. W. C. Dreier, manager of the Hatillo Fruit Co. Farm near the Station. The only comparison of this cane we have is with Rayada grown at the Hatillo Fruit Farm and ground at Victoria Central. The figures are

as follows, the cane being 19 months old when ground on 21st March, 1924:

Variety	Tns. Cane p. Acre	Sucrose	Purity	Yield Factor
P. R. 472	36.3	17.15	88 8	12.49
Rayada	22 2	16 51	91.0	12.28

Erect, good vigor, fine stooler. Stalks rather short, but of good girth, yellowish green changing to uniform brownish red, about same shade as D-504, heavy bloom. Internodes rather short, tumid, and appressed at sides, stagerred, no furrow. Nodes constricted, oblique; growth ring narrow, 2-4 mms., slightly elevated, concolorous; root band narrow and oblique, concolorous; rudimentary roots small, numerous, 4-5 in rows, concolorous; leaf scar glabrate and appressed behind; glaucous band broad, constricted and rather inconspicuous. Buds medium size, 7-9 mms., plump, reaching growth ring, orbicular, germination subdorsal, purple; margins broad and flat, extending to base, lannation along fibro-vascular bundles, heavy basal places. Leaf sheaths with some dorsal lannation, sides glabrate, heavily tinted, inner base lightly splotched with purple; throat medium width, dark, lannated with very short, appressed hairs and coarse, straggling hairs on margins, tendency to split; collar broad but indistinct, reaching midrib, glaucous; ligule narrow, 2-4 mms., at sides, broadening and becoming peaked at center, no ligular process. Leaf blades plicate with declining tips, medium width to broad, 7-9 cms., dark green with conspicuous white midrib, margins serrated to base, sparse basal ciliation.

Certainly worthy of further trial.

PR-487.

Parentage unknown.

Recumbent, good vigor, stalks long, rather slender, pale purple, abundant bloom. Internodes long, very slightly tumid, appressed at sides, perpendicular to stalk, furrow narrow, flat and indistinct. Nodes even; growth ring narrow and prominent, widening at convex side of curve as cane bend upward from declining position, parallel, brownish green changing to concolorous; rudimentary root band narrow, 3-5 mms., oblique, concolorous; rudimentary roots conspicuous, but very few and scattered, 3-4 in rows, purplish; leaf scar glabrate, appressed behind glaucous band constricted and only fairly well defined. Buds orbicular, small, 8-10 mms., never exceeding growth ring, germination apical, margins wide, flat, shouldered at base, glabrous, but with short and distinct apical tuft, no basal place.

Leaf sheaths very heavy on both back and sides, green, inner base heavily tinted with purple, slightly glaucous; throat lannate with scanty marginal vestiture, no marginal tufts; collar rather narrow, well defined and reaching midrib, grayish color, glabrate, glaucous; ligule medium width, 3–5 mms., nearly even; ligular process none. Leaf blades spreading with declining tips, medium width, 7–9 cms., margins ciliated and distinctly serrulated on upper half and almost even towards base, long straggling hairs at base.

The following analyses have been made with samples from Station plats ground in the laboratory mill:

Date	Age	Extr.	Brix	Sucr.	Gluc.	Purity	Fiber
V-27-1918	Plant	....	18.28	15.50	. ..	85 08	....
III-21-21	18 mo.	68.9	18.40	16 48	0.815	89.28	12.44
Cristalina	18 mo.	67.5	21 18	19.44	0 898	91.78	18 00
I-12-20	R 8 mo.	68.1	16 56	18.79	....	88.27	8th of 17
Mar., 1920	R 11 mo	59 6	18.94	16.76	. ..	82 27	7th of 15
V-12-20	R 18 mo	57 8	22.85	18 84	....	84.29	.. ..
Cristalina	R 18 mo	..	. .	20.46	...	90 85	....
III-28-21	P 10 mo.	67.7	17.20	14 29	1.360	83.08	12.92
Cristalina	P 10 mo.	70 5	18.00	16 28	0.650	90 44	10 62
IV-27-21	P 11 mo.	60.8	18 20	14.14	1.670	77 69	12 54
Cristalina	P 11 mo.	69.2	18.30	17.15	0 200	93.71	12.32
IV-6-22	P 12 mo.	62 9	17.78	15 32	1.287	86 85	....
Cristalina	P 12 mo	62.6	18.61	17.22	0.697	92.50	... .

These analyses indicate that it is characterized by a comparatively low sugar content. It is now planted out to tonnage experiments in comparison with the other PR canes and BH–10(12) and final opinion on its merits must await the outcome of these tests.

PR–491.

Parentage unknown.

Erect, at length recumbent, good vigor and good stooler. Stalks long, medium girth, dull purple, with irregular and scar-like discolorations, heavy bloom. Internodes long, barrel-shaped, perpendicular to stalk, decided tendency to split, furrow distinct, broad and flat. Nodes constricted; growth-ring wide and prominent, widening at convex side of curve as cane bends upwards from the recumbent position, oblique, reddish-brown changing to concolorous; root band narrow, 3 to 5 mm., oblique, dark green changing to concolorous; rudimentary roots conspicuous, but very few and scattered, 2 to 3 in rows, purple; leaf scar ciliated, prominent in front and appressed behind; glaucous band constricted and only fairly well defined. Buds triangular-ovate, varying from small to medium, 6 by 8 to 10 by 12 mm., exceeding growth ring by one-third, germination apical, margins narrow to medium, with scanty vestiture of rather long hairs, distinct apical tuft of long hairs, basal placs with vestiture of short hairs.

Leaf sheaths with scanty dorsal vestiture, at length glabrate, green with purplish tint, somewhat glaucous, inner base slightly tinted with purple; throat lannated with long hairs; collar medium width, well defined, reaching midrib, glaucous; ligule narrow to medium, 3 to 5 mm., fimbriate; ligular process none. Leaf blades sub-erect, with declining tips, broad, 10 to 12 cms., margins distinctly serrulated on upper half, ciliated below straggling hairs at base.

This is a fine-looking cane, which has done fairly well at the Hatillo Fruit Farm, but turned out rather poorly in Mr. Earle's experiments at the Aguirre Central. In 1921 gummosis showed up in the original planting of this variety at the Hatillo Fruit Farm. The first and second ratoons, however, made good growth and showed no external signs of the disease, although some gum showed up at each harvest. As third ratoons in 1923–24, the cane continued to make good growth, but a sample brought in for analysis on 28th March, 1924, although giving a good analysis, showed the gum again. Stools on either side of this infected stool, of other varieties, have not become infected.

The record of this cane follows:

Variety	Location	Age	Extract	Brix	Sucrose	Glucose	Purity
P. R.-491	Ins. Sta.	Pl 12 m.	V-27-18	16 20	13 30	....	82.09
P. R.-491	Ins. Sta.	Pl 18 m.	70 0	18.10	16 50	0 91	91.16
Cristalina	Ins. Sta.	Pl. 18 m	67.5	21.18	19.41	0 40	91.78
Above pair of analyses made on 21st March, 1921.							
P. R.-491	Ins Sta	Pl. 17 m.	61 1	15 95	12 10	1.90	75 86
P. R.-491	Ins. Sta	Rat 8 m.	60 7	17.49	15 04	5th of 17	85 99
P. R.-491	Ins. Sta	Rat. 11 m	62 5	19 02	16 80	5th of 15	88.32
Above plant analysis made 8th April, 1921; ratoons in January and March 1920.							
P. R.-491	Ins. Sta	Rat 13 m.	66.7	20 45	17 97	V-18-20	87.87
Cristalina	Ins Sta	Rat. 13 m.	...	..	20 46	V-1[illegible]-20	90 85
P. R.-491	Ins. Sta.	Pl. 10 m	70 0	16 00	12.81	2 02	80 09
Cristalina	Ins. Sta.	Pl. 10 m	70 5	18 00	16 28	0 65	90 44
Above pair of analyses on 28th March, 1921; pair below, April 28th, 1921.							
P. R.-491	Ins. Sta.	Pl 11 m	64 9	17 50	14 92	1 55	85 25
Cristalina	Ins Sta.	Pl 11 m	69.2	18 30	17 15	0.80	93.71
P. R.-491	Aguirre	Pl. 13 m	..	17.00	13.66	I-18-23	80.40
P. R.-491	Aguirre	Pl 14 m.	....	17 25	13 76	II-24-23	78 90
P. R.-491	Aguirre	Pl 15 m	..	15.90	12 38	III-21-8	77 80
P. R.-491	Hatillo	Rat 12 m.	73 8	13 65	11 01	IV-28-24	80 66

PR-492. See Plate V, opposite page 239.

Parents unknown.

Erect, at length recumbent, very good vigor and good stooler. Stalks long, medium to stout, green to yellow, no flush or bloom. Internodes long, tumid, very slightly staggered; furrow traces to none. Nodes constricted; growth ring broad and prominent, paral-

kal, reddish-brown to concolorous; root band wide, 4 to 6 mm., parallel and concolorous; rudimentary roots conspicuous, few and scattered, 3 to 4 in rows, brown; leaf scar, glabrate at back, and distinctly lannated in front, broad and prominent in front and appressed behind; glaucous band slightly constricted and only fairly well defined. Buds ovate, medium size, 9 to 11., sometimes exceeding growth ring, germination apical, margins of medium width and with abundant vestiture of long hairs, heavy apical tuft, light basal place. Leaf sheaths with scanty vestiture at back, sides glabrate, green with purplish tint, inner base slightly tinted, glaucous; throat lannated with short appressed hairs, long straggling hairs at sides; collar medium width, well defined, reaching midrib, gray color, very slightly lannated with minute velvety hairs; ligule narrow, 2 to 4 mm., nearly even; ligular process none. Leaf blades spreading, with declining tips, medium to broad, 8 to 11 cms., margins uniformly serrulated, long ciliae at base.

This very excellent variety and its sister cane, PR–483, which it closely resembles, but from which it can easily be distinguished by its long apical tuft, constitute what is probably the best pair of Porto Rican seedlings so far developed. It is a general-purpose cane, doing well on both *vegas* and hills gives, excellent tonnage under most conditions and is a high sucrose cane of quite early maturity, which, however, stands up well in the field. Earle considers it quite resistant to mosaic. Mr. Brebner, in charge of cultivation at Central Aguirre—eastern section—advised the author of a yield of 60 tons per acre of this variety during the first half of January, 1925. Three fields at their Hacienda Carmen gave in tons sugar per acre, 5.49, 6.18 and 6.09. A condensed record of its analyses follows:

Variety	Date	Location	Age	Extract	Brix	Sucr.	Gluc.	Purity
P R.-492.....	Apr , 1920	Ins. Sta....	Pl. 12 mo...	65.21	19.18	17 49	....	91.18
P R.-492....	Dec , 1920	Ins. Sta.....	Rat. 18 mo..	72 00	16 79	14 12	2.68	84.09
Av.Cheribón	Dec., 1920	Ins. Sta ...	Rat. 18 mo..	....	..	18.69	1.67	85.88
P. R.-492....	Jan., 1921	Ins. Sta.....	Rat. 14 mo.	68.00	18 25	16.28	1.09	89.20
Cristalina ...	Jan , 1921	Ins. Sta.	Rat. 14 mo.	71.40	17.80	15.84	0.64	86 67
P. R.-492	Feb., 1921	Ins Sta.....	Rat. 15 mo.	67 70	19.70	18 11	0.65	91.92
Cristalina ...	Feb., 1921	Ins. Sta....	Rat 15 mo..	71.40	18.90	17.40	0.80	92.06
P. R.-492....	May, 1921	Ins. Sta	Pl. 17 mo ..	61.50	19.22	17.88	0.84	90.16
P R -492. ..	Apr , 1921	Ins. Sta.....	Pl. 18 mo...	71 60	20.55	18.59	0.88	90.41
Cristalina ..	Apr , 1921	Ins. Sta. .	Pl. 18 mo...	68.90	19.80	18 88	0 20	94.92
P. R -492....	Sept 1922	Aguirre ...	Pl. 9 mo...	Tns. A.-47	12.90	8.84	....	68.50
P. R.-492....	May, 1926	Ins Sta.....	Rat. 18mo..	Tns. A.-18	20.40	18.05	....	88.40
H-109.......	May, 1926	Ins. Sta....	Rat. 12 mo	Tns. A.-25	18 95	16.70	......	88.10

This is a most excellent record and PR–492 could well be more widely distributed than it actually is.

PR-492, Red.

Mr. W. C. Dreier, manager of the Hatillo Fruit Farm on the Trujillo Alto Road, has a cane which he obtained from the Station as PR-492 some five years ago, which in everything but color and even to the characteristic apical tuft, is identical with the yellow cane we have at the Station and widely distributed over the Island. It has also proven to be of similar chemical and cultural characteristics and has given him excellent results on the poor, red, shaly hillsides of that section. It would appear that, in securing a few canes for seed from the Station, it just happened that he obtained a stool representing a red sport of this promising kind A few analyses from Mr. Dreier's place follow.

Variety	Age	Date	Brix	Sucrose	Glucose	Purity	Yield Factor
P. R. 492 (Red)....	Plant 11 m	VI-7 '4	16 8	14 46	1 28	86 07	10 04
B H 10 (12)	Plant 11 m	VI 7 24	19 2	16 82	0 80	87 60	12 42
P. R 492 (Red)	Rat 11 m	VI 7 24	19 8	18 08	0 48	91 81	13 62
P. R 492 (Red)	Plant 20 m.	II 3 25	14 8	12 06	1 90	81 76	8 54
P. R 492 (Red)	Plant 14 m	V-14 26	18 2	15 92	0 83	87.71	
B. H 10 (12)	Plant 14 m	V 14 26	18 85	16 80	0 85	89.12	....

This kind should be brought back to the Station and tried out in tonnage experiments in comparison with the yellow type here. It gives considerable promise.

PR-502.

Parentage unknown.

Erect, then recumbent, good vigor, fine stooler. Stalks long, medium girth, yellow at first, becoming olive-green on older joints, no flush, heavy gray bloom. Internodes medium length, slightly tumid and decidedly shouldered at back opposite bud, perpendicular to stalk, furrow broad and shallow. Nodes constricted, oblique; growth-ring wide, 4 to 6 mm., oblique, nearly even, brownish changing to concolorous; root-band narrow, oblique, light creamy to yellow and then to green; rudimentary roots few, small, scattered, inconspicuous, in rows 3 to 4, covered with white wax, yellow-brown to concolorous; leaf scar glabrate, appressed behind; glaucous band narrow, constricted, inconspicuous. Buds medium to large, 8 by 10 mm., triangular-ovate, exceeding growth-ring by one-third to one-half, germination apical; margins medium width, on upper three-fourths only, flat, slightly lannated, shouldering at sides, long, sparse, apical tuft; light basal places. Leaf sheaths with heavy vestiture of tawny but deciduous hairs at back, sides glabrate, glaucous, very lightly tinted without, heavily within; throat medium width, dark colored, lannated, with short appressed hairs, long straggling hairs

at margins; collar medium width, reaching midrib, brownish, covered with white wax, ligule narrow at sides, 2 to 4 mm., moderately widening at center, nearly even, no ligular process. Leaf blades spreading, wide, 7 to 8 cms., dark green, minutely serrulated on upper half only, smooth below, sparse basal ciliation.

For no apparent reason, since the only available Station analysis of this good-looking and promising cane was quite good, this kind had been allowed to disappear from the Station plats when the author arrived here in October, 1923, and, after seeing its promising development at the Hatillo Fruit Farm, he obtained a few seeds from Mr. Dreier to multiply for tonnage experiments, which are now under way and in which this cane is showing up well. The first series of analyses given below is the only one available from Station cane and was made on 23rd March, 1921, of 18-month-old plant cane, while the second series is from the Hatillo Fruit Farm and obtained from actual factory results at Central Victoria:

Variety	Extra.	Brix	Sucr.	Gluc.	Purity	Tns Cane per acre	Age
P. R.-502	64 2	17.90	15.80	0 94	88.26	....	Pl. 18 m.
Cristalina	67.5	21 18	19.44	0.40	91.78	....	Pl. 18 m.
P R -502	27th Mar., 1924		17 08	....	88 20	48.4	Pl 19 m
Rayada	27th Mar., 1924		16.51	.. ..	91.00	22.2	Pl. 19 m
P. R.-502	28th Apr., 1924		15.82	....	86.92	....	Rat. 19 m

PR-503.

Parents unknown.

Recumbent, good vigor, fair stooler. Stalks long, medium diameter, purple, heavy bloom. Internodes medium length, cylindrical, slightly enlarged at base opposite bud, sometimes distinctly shouldered, slightly staggered, furrow shallow. Nodes even to slightly constricted; growth-ring medium width, even to slightly elevated, parallel, at first yellowish, then dark purple; root-band narrow, oblique, concolorous; rudimentary roots inconspicuous, few and scattered, 3 in rows, white then purplish; leaf scar glabrous, appressed behind; glaucous band constricted, broad and well defined. Buds hemispheric-triangular, medium size, 9 by 11 mm., exceeding growth-ring by one-third, germination sub-apical; margins wide, nearly even, purple, glabrous. Leaf sheaths with scanty dorsal vestiture of deciduous hairs, tinted, inner base very lightly tinted, faintly glaucous; throat slightly lannated; collar broad and well defined, reaching midrib, gray color, glaucous; ligule narrow, 2 to 4 mm., nearly even; ligular process none. Leaf blades suberect, rather nar-

row, nine to eleven cms., margins minutely serrulated on upper half, almost smooth below, very sparsely ciliated at base.

Another variety on which we have very meagre information and which has recently been planted out in tonnage experiments in comparison with other PR canes and with BH–10(12) as a check. The record we have follows, all analyses being from Station plats except the last, which is from very steep, high, red clay hillside at the Hatillo Fruit Farm:

Variety	Date	Age	Extr	Brix	Sucr	Glucose	Purity
P. R. 508	V-27-18	Pl 12	..	16 68	13 30	16th of 20	79.00
P. R. 508	I-12-20	Rat. 8	56.8	15.26	11 88	15th of 17	71.29
P. R 508	Mar, 20	Rat 11	57 5	17 50	14 97	13th of 15	85 34
P R. 508	May, 20	Rat 13	58 9	21 45	18 11	....	84.47
Cristalina	May, 20	Rat 13	..		20 46	......	90 85
P. R 508	Mar 21	Pl 18	65 2	16 70	13.95	1.08	83 53
Cristalina	Mar 21	Pl 18.	67 5	21 18	19.44	0 40	91 76
P. R 508	May, 21.	Pl 17	60 8	15 35	11 54	1 93	75.17
P R 508	Apr 25	Rat 21	55.8	15 45	12 50	....	80.90

A very poor record indeed and one that does not offer much indication of its becoming a useful cane here.

The Porto Rico Seedlings Produced in 1915

PR–507.

A cross of Otaheite and B–347.

Erect, finally recumbent, only fair vigor, long and slender, yellow, slight bloom. Internodes long, cylindrical, slightly staggered, furrow narrow and very shallow, decided tendency to split. Nodes even; growth-ring inconspicuous, medium width, 3 to 5 mm., even parallel, concolorous; root-band narrow, parallel, concolorous; rudimentary roots inconspicuous, few and scattered, 3 to 4 in rows, concolorous; leaf scar glabrate, appressed behind; glaucous band indefinite and rather even. Buds ovate, small, 6 by 8 mm., never exceeding growth-ring, germination sub-apical, narrow, flat margins with scanty vestiture of short hairs. Leaf sheaths sparsely lannated at back, sides glabrate, tinted, somewhat glaucous; throat lannate with short appressed hairs; collar medium width, well defined, reaching midrib, lannated; ligule narrow, 2 to 4 mm., nearly even; ligular process remarkably developed on one side only, 2 to 3 inches. Leaf blades erect with declining tips, rather narrow, 8 to 10 cms., margin serrulated and ciliated, with long, straggling hairs at base.

We have very little available data on this cane, for some unexplainable reason, and must await the results of the tonnage experiments planted out with it and its sister canes last fall before we

can form any opinion as to its value. The scanty record which exists of it at the Station follows:

Variety	Date	Age	Extract	Brix	Sucrose	Glucose	Purity
P. R.-507	Feb., 1918	Pl 19 mths	...	22 10	19.90	....	90.05
P. R.-507	Mch., 1920	Pl. 12 mths.	62.5	20 12	18.15	....	90.20
P. R.-507	Apl., 1921	Pl. 18 mths	67 1	19.65	17.97	0.58	91.45
Cristalina	Apl., 1921	Pl. 18 mths.	68 9	19 80	18 88	0.20	94.92

Certainly there is nothing in any of the few analyses to justify the ignoral of this cane at the Station for many years.

PR-543.

A cross of Otaheite and B-347.

Recumbent, good vigor, good stooler. Stalks long, medium diameter, greenish-yellow base color, changing through brown to wine color, little bloom. Internodes medium length, cylindrical, slightly enlarged at base opposite bud, distinctly staggered, furrow broad and very shallow. Nodes nearly even, growth-ring medium width, elevated, oblique, yellowish-brown to concolorous; root-band narrow, oblique, yellowish-green; rudimentary roots inconspicuous, few and scattered, 2 to 3 in rows, purplish to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind, glaucous band constricted, broad and well defined. Buds ovate, small to medium, 8 by 10 mm., exceeding growth-ring by one-third, germination apical, flat, narrow margins with little vestiture of short hairs, small apical tuft, light basal placs. Leaf sheaths with abundant dorsal vestiture of short, brown hairs, purple, inner base extremely lightly tinted with purple, very slightly glaucous; throat lannated, with short appressed hairs; collar medium width, well defined, reaching midrib, lannated with velvety hairs; ligule narrow, 2 to 4 mm., even; ligular process none. Leaf blades spreading with declining tips, broad, 10 to 12 cms., dark green, margins uniformly serrulated and sparsely ciliated at base.

This is another seedling, of the same parentage as PR-545, which has the same reputation here for late maturity and low sugar content, which reputation is not absolutely confirmed by the analyses available, hence, with its sister cane it has been planted out in tonnage experiments at the Station recently in order to get some more definite figures on which to base an opinion. In plats at the Station but it is doing well in the Station field as well as at Central Cambalache. On also at the Hatillo Fruit Farm on the Trujillo Alto Road. Our rather scant record on it follows; all but the last two series being from canes off of Station variety plats. The last two

series of analyses are from cane grown at the Hatillo Fruit Farm by Mr. W. C. Dreier:

Variety	Date	Age	Extract.	Brix.	Sucr.	Glucose	Purity	Fiber
P. R.-548	Feb., 1918	Pl. 19 mo. ..	....	21 50	20.12	....	93 61	......
P. R -548	Apr., 1921	Pl. 18 mo ..	68.2	19 85	17.10	0.27	91.47	12.72
Cristalina ...	Apr , 1921	Pl. 18 mo. ..	68 9	19 80	18 88	0 20	94.98	11.55
P R 548	Jan., 1920	Rat 10 mo..	61.7	4th of 24	16 20	....	92.19	......
Cristalina	Jan., 1920	Rat. 12 mo..	64 6	.....	17.47	... .	91.56	......
P. R.-548	Mar., 1920	Pl 12 mo ..	64.1	18 80	16 80	....	89 70	......
P. R -548	May, 1926	Pl. 14 mo ..	.. ..	18.60	16.99	0.33	91 34	.....
B -H.-10(12) ...	May, 1926	Pl. 14 mo ..	... .	18.85	16 80	0 85	89 12	......
			T. c p a.			T. c s. a.		
P. R.-548 ..	May, 1926	Pl 14 mo. ..	19 6	....	15.20	2 15	88 40	......
B.-H.-10(12) ...	May, 1926	Pl. 14 mo. ..	21.8	....	17.90	2 92	89.36	......

Here again, and even more strongly than in the case of the record of PR–545, the figures found fail absolutely to confirm the dictum that this is a poor sucrose cane. We must, however, await the final results from our tonnage experiments before attempting to give a definite opinion on the probable value of this cane.

PR–545.

A cross of Otaheite with B–347.

Erect, then recumbent, very good vigor, fine stooler. Stalks long, good diameter, green to yellow, no flush, some bloom. Internodes long, appressed, slightly staggered, furrow well defined, broad and shallow. Nodes nearly even, slightly constricted at back; growth-ring wide, elevated, especially at back, oblique, yellowish-brown to concolorous; root-band medium width, parallel, concolorous; rudimentary roots crowded, 4 to 6 in rows, purplish-brown to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds lanceolate, very large, 12 to 16 mm., exceeding growth-ring by one-third to one-half, germination apical, narrow flat margins, shouldered at base, with scanty vestiture of appressed hairs. Leaf sheaths with dense dorsal vestiture of short, tawny hairs, sides glabrate, slightly tinted within and without, glaucous; throat lannated with long coarse hairs; collar broad and well defined, reaching midrib, glaucous; ligule narrow, 2 to 4 mm., nearly even; ligular process about 1½ to 2 cms. long, on one side only. Leaf blades spreading with declining tips, wide, 10 to 12 cms., rather light green, margins minutely serrulated on upper half and almost smooth at base, very sparcely ciliated at base.

This is an extremely vigorous cane, which has the reputation of being very low in sugar here at the Station, but on which we need more definite data before ruling it out on this count. Richardson Kuntz, on page 36 of the Thirteenth Annual Report of this Station,

states that this variety has shown itself to be so late maturing and so low in sugar content that no more trials would be conducted with it here. Later we have planted it out in tonnage experiments at the Station along with other PR varieties on which we lack definite data and with BH-10(12) as a check. At both Centrals Cambalache and Plazuela this kind is making a most vigorous growth. Its incomplete record at the Station follows:

Variety	Date	Age	Extract	Brix	Sucrose	Glucose	Purity
P. R.-545	Feb., 1918	Pl 19 mo.	....	19.00	17.30	....	91.05
P. R.-545	Mch., 1920	Pl. 12 mo.	65.9	18.92	17.10	....	90.38
P. R.-545	Apl., 1921	Pl. 18 mo.	71.0	17.00	14.74	0.85	86.20
Cristalina	Apl., 1921	Pl. 18 mo.	68.9	19.30	18.33	0.20	94.92
P. R.-545	Mar., 1920	Rat. 15 mo.	....	17.63	15.78	....	89.50
P. R.-545	Oct., 1924	Pl 12 mo.	....	14.90	10.89	....	73.09
P. R.-545	Dec., 1924	Pl 18 mo.	....	16.40	13.49	....	82.26

Except for the last two analyses—and the time of the year when these were made must be noted!—this record certainly does not bear out the record as a poor sugar producer which this kind has here.

PR-561.

A cross of Otaheite with B-347.

Erect, very good vigor, good stooler. Stalks long, medium diameter, green with slight flush, abundant bloom, discolored striations. Internodes medium length, slightly appressed, enlarged at base opposite bud and sometimes distinctly shouldered, staggered, furrow narrow and shallow. Nodes constricted especially at back; growth-ring broad, elevated, parallel, brownish to concolorous; root-band wide, oblique, concolorous; rudimentary roots crowded, 3 to 5 in rows, brownish to concolorous; leaf scar glabrate, appressed behind; glaucous band constricted, broad and well defined. Buds ovate to sub-orbicular, small, 7 by 9 mm., not exceeding growth-ring, germination sub-apical; narrow margins, heavily lined with long, coarse hairs which at times cover entire back. Leaf sheaths heavily lannated with long, white hairs, sides glabrate, yellowish-green color, inner base heavily tinted with purple, no wax; throat narrow, lannated, long marginal tufts; collar narrow, well defined, reaching midrib, glaucous; ligule narrow, 2 to 4 mm., fimbriate; ligular process 1 to 1½ inches, on one side only, starting below collar. Leaf blades erect with declining tips, rather narrow, 8 to 10 cms., margins distinctly serrulated on upper half and uniformly ciliated below.

A vigorous-growing cane which has been rather widely distributed about the Island without too much being yet known as to its sugar-production qualities. Seen by the writer at Cambalache, Plazuela

and at the Hatillo Fruit Farm on the Trujillo Alto Road, near the Station, at all of which it has made good development. Our record for this variety follows, all analyses being of cane from Station plats:

Variety	Date	Age	Extr.	Brix	Sucr.	Gluc.	Purity
P. R.-561.	Feb., 1918	Pl 19 mo.	.....	21.50	20 00	....	93.00
P. R.-561.	Jan., 1920	Rat. 10 mo	62.10	......	15 48	..	85 72
P. R.-561.	Mch., 1920	Pl 12 mo.	58.57	16.10	12.86	.. ...	79.82
P. R.-561.	Mch., 1920	Rat. 15 mo	.... .	18 51	16 20	.. .	87.57
P. R.-561.	Apl., 1921	Pl. 18 mo	70 40	15.60	12 28	1.98	78 71
Cristalina	Apl., 1921	Pl. 18 mo	68.90	19 30	18.38	0.20	94 92

An uncertain record at the best.

PR-579.

A seedling of D-109.

Erect, good vigor, fair stooler. Stalks long and slender, color varying from greenish-yellow, through rose and purple to wine color, heavy bloom. Internodes medium length, cylindrical above and slightly tumid at base, staggered, no furrow. Nodes constricted; growth-ring narrow, even, parallel, concolorous; root-band narrow, especially at back, oblique, concolorous; rudimentary roots numerous, 2 to 3 in rows, purplish to concolorous; leaf scar glabrate, appressed behind; glaucous band constricted, broad and well defined. Buds orbicular-ovate, small to medium, 8 by 10 mm., reaching growth-ring, germination dorsal, margins flat, wide and even, covered with scanty vestiture of short hairs, no apical tuft. Leaf sheaths with abundant dorsal vestiture of deciduous, tawny hairs, sides glabrate, tinted within and without, glaucous; throat broad, lannated; collar broad, well defined, reaching midrib, glaucous; ligule narrow, 2 to 4 mm., nearly even; ligular process none. Leaf blades erect with declining tips, narrow, 6 to 8 cms., margins minutely serrulated on upper half, long straggling hairs at base.

A vigorous-growing variety of rather doubtful value. The data we have on it follows:

Variety	Location	Date	Age	Extract	Brix	Sucr.	Gluc.	Purity
P. R.-579	Ins. Sta.	I-16-20	Rat. 10 m.	56.8	....	18 08	..	89 02
Cristalina	Ins. Sta	I-16 20	Rat. 11 m.	64 6	....	17 47	....	91.58
P. R.-579	Ins Sta.	Mar., 16-20	Pl. 12 m.	55 6	19 80	16 60	.. ....	86.54
P. R.-579	Ins. Sta.	Mar., 16 20	Rat. 14 m	.... ..	18 94	16 28	... ..	85.95
P. R.-579	Ins. Sta.	Mar., 16-21	Pl. 10 m.	61 7	15 50	12 59	1 08	81 22
Cristalina	Ins. Sta	Mar., 16-21	Pl. 10 m	70 5	18 00	16 28	0.65	90 44
P. R.-579	Ins Sta.	Apr., 16-21	Pl. 11 m.	64 1	18 00	15 43	1.11	85 72
Cristalina	Ins. Sta	Apr., 16-21	Pl. 11 m.	69.2	18 30	17 15	0.30	93.71
P. R.-579	Aguirre	Jan., 16-23	Pl. 13 m.	....	21 35	18 18	.... ..	85 00
P. R.-579	Aguirre	Feb., 16-23	Pl. 14 m	....	20 75	17.01	....	82.00
P. R.-579	Aguirre	Mar., 16-23	Pl 15 m	... .	21 10	17 55	....	79 80
P. R.-579	Aguirre	Dec., 16-24	Pl. 16 m	....	17 60	15.13	.. ....	86 00
P. R.-579	Aguirre	Dec., 16-24	Pl. 16 m.	... .	18 90	16.44	....	87.10

On the whole this is a very creditable record.

PR-649.

A seedling of B-3750.

Erect, good vigor, fine stooler. Stalks long and thick, green, no flush, heavy bloom, discolored striations on some joints. Internodes medium length, tumid, staggered, furrow slight to none. Nodes constricted; growth-ring wide, elevated, parallel, reddish-brown to concolorous; root-band wide, parallel, concolorous; rudimentary roots few and scattered, 3 to 5 in rows, concolorous to brown; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds triangular-lanceolate, large, 10 by 14 mm., exceeding growth-ring by one-third, germination apical, margins flat, wide, abruptly shouldered at base, nearly glabrate, heavy basal placs. Leaf sheaths with dorsal vestiture of deciduous hairs, inside base heavily tinted with purple, sligthly glaucous, green; throat broad and lannated, long and conspicuous tuft of straggling hairs at sides; collar broad, well defined, reaching midrib, lannated with appressed velvety hairs; ligule rather broad, 3 to 5 mm., nearly even; ligular process short, 1 to 2 cms, on one side only. Leaf blades spreading with declining tips, medium width, 8 to 10 cms., dark green, margins distinctly and uniformly serrulated, heavy ciliation at base.

A vigorously growing variety on which we have very little information and which has now been planted out to tonnage experiments in comparison with the other PR canes and with BH-10(12) for a check. The record which we have of it follows; all from Station plats:

Variety	Date	Fiber	Age	Brix.	Sucr.	Gluc	Purity
P. R.-649	Feb., 1918	15th of 24	Pl 19 mo...	21 40	17.72	. ...	83.80
P. R.-649	I-16-20	10 70	Rat. 10 mo..	. ...	15.68	... ...	86.66
P R.-649	IV-20-21...	11.55	Pl 18mo ...	16.60	14 23	1 29	85.72
Cristalina	IV-20-21 ..	....	Pl. 18mo ..	10 80	18.33	0.20	94.92
P. R.-649	Mar., 1920	17th of 17	Pl 12mo...	15 89	12 88	.. ....	85.15
P. R.-649	Mar., 1920	1st of 8	Rat. 18 mo..	19 21	17 40	....	88 23
P. R.-649	Oct., 1924..	....	Pl 12 mo ..	14.45	10 56	... ...	73.07

PR-662.

A seedling of B-3750.

Erect, fair vigor, good stooler. Stalks long and of medium girth, greenish-yellow, no flush, heavy bloom. Internodes long, cylindrical and sometimes tumid, staggered; furrow broad and very shallow. Nodes slightly constricted; growth-ring broad, slightly elevated, parallel, greenish-brown to concolorous; rudimentary roots few and scattered, 3 to 4 in rows, inconspicuous, concolorous; leaf scar

glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds sub-orbicular, large 12 by 16 mm., exceeding growth-ring by one-third, margins purple and flat, wide, sometimes waxy, glabrate, germination apical, short and scanty apical tuft, light basal placs. Leaf sheaths with abundant dorsal vestiture of long hairs, sides glabrate, green, inner base slightly tinted, no wax; throat broad, dark, lannated; collar broad, well defined, reaching midrib, lannated; ligule narrow, 2 to 4 mm., nearly even; ligular process none. Leaf blades spreading with declining tips, medium to broad, 9 by 11 cms., dark green, margins uniformly and distinctly serrated, scanty ciliation at base.

This is another cane of which we have rather a scant record at the Station, which is given below for what it is worth, and which we planted out in tonnage experiments, along with the other PR seedlings on which we lack data, last fall, the results of which must be awaited before we can venture an opinion as to its probable value:

Variety	Date	Age	Extr.	Brix.	Sucr.	Glucose	Purity
P. R.-662	Feb, 1918	Pl 19 mo	....	21.10	17 14	....	82.45
P. R.-662	Jan, 1920	Rat 10 mo	64 28	....	18 40	....	92 87
Cristalina	Jan, 1920	Rat 12 mo	64 55	.	17 47	....	91.58
P. R.-662	Mar, 1921	Pl 18 mo	68 00	19 50	17 80	0.48	91.28
Cristalina	Mar, 1921	Pl 18 mo	68 90	19 80	18 88	0.20	94.92
P. R.-662	Oct, 1924	Pl 12 mo		15 70	11 58	....	78 76
P. R.-662	Mar, 1920	Pl. 12 mo.	68 01	10.18	18.67	....	92.51
P. R.-662	Mar., 1920	Rat. 15 mo.	... . .	16 88	18 50	....	82.65

There is only one really poor analyses in this admittedly rather deficient lot of analyses and it is, therefore, difficult to understand why this cane has never received any attention at the Station in past years.

PR-676.

Seedling of B-3696.

Erect, fair vigor, poor stooler. Stalks fair length and of good girth, uniformly purple, with very heavy bloom. Internodes long, cylindrical, almost perpendicular to stalk, furrow well defined, broad and shallow. Nodes constricted; growth-ring broad and elevated, parallel, brownish-red to concolorous; root-band broad, parallel, yellow to concolorous; rudimentary roots few, scattered and inconspicuous, 3 to 4 in rows, concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band constricted, broad and well defined. Buds orbicular, large, 12 by 16 mm., scarcely exceeding growth-ring, purple, germination sub-dorsal, margins wide, abruptly shouldered at base, glabrate, short, but conspicuous apical tuft, heavy basal placs. Leaf sheaths glabrate, glaucous, inner

base slightly stained with purple; throat wide, with very scanty vestiture of long, coarse hairs at margins; collar wide, well defined and reaching midrib, glaucous; ligule broad, 3 to 5 mm., fimbriate; ligular process broad, 1½ to 2 cms., on one side only. Leaf blades spreading with declining tips, wide, 10 to 12 cms., dark green, margins uniformly and minutely serrulated, very scanty basal ciliation.

The writer was inclined to omit this cane from this list of mostly somewhat promising canes on account of its poor germination and stooling, but a study of the records at the Station shows such little definite data available on it that we have decided to give it a final chance in tonnage experiments in comparison with the other PR canes rather than to try to definite conclusions on its conduct from observations under limited conditions.

Of all the PR varieties planted out by the author in September, 1924, for a comparative study, this cane showed consistently the poorest germination. Ten weeks after planting, for instance, this variety averaged only 1½ shoots above ground, against 9½ per hole for the PR–358, the best germinater in this field. Three weeks later the number of canes in the PR–676 plat was identically the same, while all the other varieties were beginning to stool vigorously.

The meagre record of PR–676 which we have from the Station plat follows:

Date	Age	Extr	Brix.	Sucr.	Purity	
Feb., 1918	Pl 19 mo .	..	21 80	12.80	78 80	
Jan., 1920	Rat 10 mo. ..	60 0		15.14	88.92	20th in Suc. out of 24
Mch., 1920	Pl 12 mo. ..	56 6	19.02	16 94	93 81	11th in Suc. out of 17
Mch., 1920	Rat 15 mo ...	.	19.11	16 48	86.28	3rd in Suc out of 8

This small record is too variable to form any opinion of its sucrose-producing qualities, but on the whole it is not particularly encouraging.

Rayada. See Plate XXVII, opposite page 283.

(=Striped Cheribón, =Louisiana Ribbon.) Probably introduced in the early days of the nineteenth century as an admixture with Otaheite. Now found in pure and mixed plantings in all parts of the Island. Since the epidemic of 1872 this has been the most widely planted cane in Porto Rico until the advent of BH-10(12) and SC–12/4.

In all respects except color indistinguishable from Cristalina, which see for detailed description. In this variant the stalks are striped with irregular bands of green or yellow and dark purple. The color

scheme is quite variable. Sports from one form to the other or to the Morada are frequently found in the fields.

Most planters have a decided preference for either Rayada or Cristalina, but they can seldom give a valid reason for their choice. Considerable study over a term of years has so far failed to detect any constant difference between them in cultural characters. Everything said under Cristalina in regard to disease resistance, and adaptability to general planting may be repeated here. Probably the majority of planters will claim that Cristalina is the richer of the two in sucrose. Our plantings have not been so arranged as to properly test this point. The few analyses in our records that are comparable are given below for what they may be worth, but the evidence is by no means conclusive.

Kind			Extr	Brix	Sucr	R. S.	Purity	Fiber
Rayada ...	2-4 21	Pl 16 mo	64 8	18 55	17 27	0 32	92 98	11 26
Cristalina	2 4 21	Pl 16 mo	65 2	18 40	17 27	0 65	93 95	11 88
Rayada	1 19 21	Pl 15 mo	69 7	18 25	16 42	0 84	89 91	12 12
Cristalina .	1 19-21	Pl 15 mo	70 0	17 25	15 96	0 37	92 51	9 60
Rayada	11 29 20	Pl 20 mo	61 6	16 20	14 50	0 66	89 05	11 78
Cristalina	11 29-20	Pl 20 mo	61 5	16 47	14 52	1 20	88 15	12 32
Rayada .	12 15 20	Rat 10 mo	68 2	17 68	15 98	0 65	90 12	8 90
Cristalina	12-15 20	Rat 10 mo	70 0	17 50	15.58	0 28	88.74	9 60
Rayada	12 22-20	Rat 14 mo	69 5	15 33	13 06	0 98	85 12	9 16
Cristalina	12 22 20	Rat 14 mo	70 0	17 50	15 58	0 28	88 74	9 60
Rayada	4 17-17	Pl 14 mo		21 81	20 0		93 90	

This last is our highest recorded analysis for Rayada and it is almost exactly identical with the highest recorded for Cristalina, though the two were made from different fields and in different years. So far the chemist seems to confirm the view of the field man that the two kinds are only color variants of the same original stock.

REFERENCES

ROSENFELD, ARTHUR H.—¿Es Superior Nuestra Caña Morada a Nuestra Rayada? Revista Industrial y Agrícola de Tucumán, II, 8, pp. 331–4; Ene., 1912.

STUBBS, W. C.—Results of Field Experiments with Sugar Cane. La. Agr. Expt. Sta., Bull. 6, N. S., pp. 102–42; Jan., 1891.

Rayada Mexicana.

(=Rayada.) Imported from Mexico by Central Guánica in 1919. Now planted at this Station.

Reina Caledonia.

Introduced from Trinidad by Dr. Stahl prior to 1879. This name was first proposed in Trinidad for some unknown introduced cane. Later it was considered as =Cristalina. The cane received under

this name by Dr. Stahl could not have been this kind, for it was poor and feeble in growth. He remarks that "its pompous name is in contrast to its inferior vigor." It seems to have disappeared.

*** Rosa Morada.**

Imported by Dr. Grivot Grand Court under this name, probably from Guadaloupe, prior to 1879. Said to come from New Caledonia. As nearly as can be determined from the fragmentary early descriptions this is the cane that still exists rather frequently in mixed plantings in the hill districts between Arecibo and Lares, particularly in the neighborhood of Bayaney. Curiously enough, tradition seems to have handed down no name for this cane. When pressed for a name the planters in this district usually call it "Caledonia". It doubtless has a perfectly good name in other countries, but what it is can not even be guessed at present. The one used here has not been seen elsewhere in the literature. Seed cane from Bayaney was once brought in under the name of "Salangor Rojo", but the descriptions by Dr. Stahl make it clear that he applied this name to the self-colored form of Cavengerie, here called Cavengerie Roja, and not to the present variety. The name Sarangola Roja was once applied to this cane by a *colono* near Lares.

Erect, vigorous, stools well, arrows rather freely. Stalk long, medium to medium stout, dull purple, fading to olive brown at maturity, little or no bloom. Internodes rather long, usually compressed laterally and somewhat larger below, furrow faint or none. Nodes constricted; growth ring wide, 4 mm , swollen, usually darker in color, conspicuous; root band oblique, 6 to 8 mm., greenish; rudimentary roots, large, crowded, brown with purplish centers, in 2 to 3 rows; leaf scar glabrous, prominent, appressed behind; glaucous band 8 to 10 mm., well defined. Buds rather large, ovate, 12 to 15 × 10 to 14 mm., exceeding the growth ring by one-third of length, margin narrow, uniform, germination apical, vestiture of appressed basal plaos and conspicuous apical tuft of long hairs. Leaf sheaths with a moderate vestiture of short hairs; glaucous, usually strongly tinted; throat lannate with short appressed hairs; collar pale brown extending into a broad whitened area along midrib, glaucous not lannate. Leaf blades suberect, the tips declined, 6 to 8 cm. wide, medium dark green, minutely serrulate.

This seems to be strictly a hill-land cane. It did not thrive in our low-land plots. In the red clay hills and on the dry coral red lands it is very much at home, seeming to be equal in growth and vigor to the Cavengerie when planted in the same fields. The few

analyses available indicate that it is much earlier in maturing. It seems to be a fairly sweet cane. It is hard to understand why it has been so completely overlooked while Cavengerie has been so widely planted. Like the latter cane it is resistant to root disease at least on dry lands but unfortunately it is equally susceptible to mosaic, from which it is suffers severely. Its reaction to gum disease is not known. This cane should certainly be tested further for high, dry lands where it can be kept clear of mosaic. It has given quite good results to Mr. Dreier on the high, dry lands of the Hatillo Fruit Farm.

Kind	Date	Age	Extr	Brix	Sucr.	R. S.	Purity	Fiber
Rosa Morada.	12 6-20	Pl 14 mo	71 6	16 19	13 14	1 59	81 82	13.82
Av 5 Cheri ...	12 6 20	Pl. 14 mo	.	...	13 69	1 67	85 86	12 29
Rosa Morada.	1 9-21	Pl 15 mo	62 5	15 75	13 13	1.82	83 36	12 0
Cristalina	1 9 21	Pl 15 mo	70 0	17 25	15 96	0.87	92 52	9.60
Rosa Morada.	5-5 21	Pl 18 mo	62 2	18 70	16 98	0.658	90 80	....

Rosa Rayada.

This name was proposed by Earle for a green and purple striped variant of the above found at Bayaney and brought into the Station collections as X–18. Exactly like the self-colored form except for green stripes on the stalks and leaf sheaths.

Saconi.

Dr. Stahl, "Revista de Agricultura", 1887, p. 174. This is probably a misprint for Sacuri. If so, it came from Jamaica. No further reference to this kind has been found.

The St. Croix Seedlings

With the exception of the famous *SC–12/4, q. v.*, which is in reality a Barbados seedling, this series has been produced at the the Virgin Islands Experiment Station in St. Croix, those previous to 1919 by Dr. Longfield Smith, who was Director of this Station under the Danish Government.

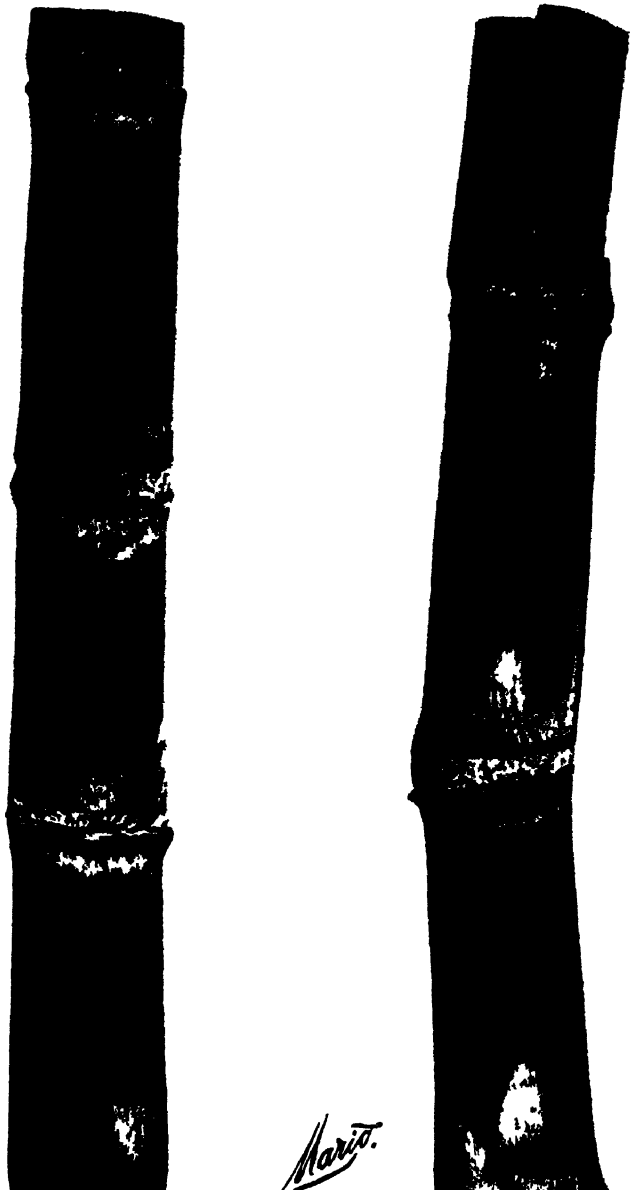
REFERENCES

Smith, Longfield—Report of the Virgin Islands Expt. Sta., 1920, pp. 7–14.

Idem—Ibid, 1921, pp. 4–5.

Sta. Cruz–12(4). See Plate XXVIII, opposite page 287.

Seedling of B–6835, produced by Bovell in Barbados. Imported by the Mayagüez Station. Seed from Mayagüez was planted at this



Saint Croix 12/4

Station in the spring of 1919. It has been considerably distributed by this (Mayagüez) Station, and has spread rapidly over the entire Island, being second only to BH–10(12) in extensiveness of distribution and percentage of Porto Rican sugar crop produced.

Erect, good vigor, fair stooler. Stalks long, medium diameter, green with reddish flush, light bloom. Internodes medium to long, cylindrical or a little compressed, staggered, furrow slight or none. Nodes somewhat constricted, strongly oblique; growth ring broad but rather poorly defined, even or somewhat elevated, yellowish; root band strongly oblique, 5 to 10 mm, concolorous or paler; rudimentary roots crowded, in about 4 rows; leaf scar glabrous, broad and prominent in front, appressed behind; glaucous band constricted, poorly defined. Buds large, lance-ovate, about 12 × 16 mm, exceeding the growth ring by one-third to one-half, margin broad, uniform, germination apical, heavy basal place, abundant marginal vestiture ending in a conspicuous apical tuft. Leaf sheaths with dense vestiture along the back, the sides glabrate, greenish or slightly tinted, somewhat glaucous, the base slightly stained purple within; throat lannate and with an abundant vestiture of hairs; collar medium width, reaching the midrib, glaucous, the margin slightly lannate; ligule about 4 mm., minutely fimbriate; ligular processes none. Leaf blades erect, usually even to the tips, flat, 7 cm. or more wide, dull green, minutely and sparingly serrulate, the bases even, not ciliate.

As in the case of D–74 and D–95, *q. v.*, this is also a Barbados cane produced by John R. Bovell, the father of so many of the world's promising seedlings, from the identically same seedling parent as our most useful cane in Porto Rico—BH–10(12). It is, hence, in no sense a St Croix seedling, having been taken with him amongst a number of unnumbered Barbados seedlings by Mr. Bovell when he made a visit in 1912 to the Agricultural Experiment Station in St. Croix, then under the charge of the Danish Government and the directorship of Dr. Longfield Smith. After long trial by Dr. Smith this finally became known at St. Croix' most valuable seedling cane. Hence it would seem that, aside from the famous H–109, most of the seedlings which have gained great reputations for themselves and contributed very materially to the advancement and prosperity of the sugar industries of countries so widely separated over the face of the globe have really originated in that little speck in the broad Atlantic—Barbados—and been produced by that grand old man of sugar-cane varietal work, the Hon. John R. Bovell, for two-score years Director of Agriculture on that emerald isle!

All around the coastal plains of Porto Rico it is difficult to choose between the BH-10(12) and the SC-12/4 varieties, which have both shown uniformly superior results to ALL OTHER CANES with which they have been grown in comparison, including Cristalina, Rayada, D-109, B-208, etc., while in the hills between Humacao and Caguas the preponderance of the evidence given below would indicate that the SC-12/4 is slightly more at home under the conditions of this most excellent cane district than its well-known sister, although very promising results have been obtained with the latter throughout this entire district also.

The BH-10(12) would seem to be more resistant to both mosaic disease and gummosis than the SC-12/4 as well as to drought.

In Central Aguirre, there is a tendency to abandon it in favor of the BH-10(12) on account of its apparent greater susceptibility to gumming. Mr. Matz considers the BH-10(12) practically immune to this dread disease, but the writer has seen a few infected canes of BH-10(12), although there is no doubt that it is more resistant than SC-12/4.

The following tables give an idea of the results obtained with SC-12/4 in distinct sections:

TABLE IX

COMPARISON OF YIELDS OBTAINED FROM SC-12(4) AND RIBBON CANES, ST. CROIX AGRICULTURAL EXPERIMENT STATION

Plant No.	Santa Cruz 12 (4)		Ribbon	
	Tons Cane per Acre	Lbs. Sucrose per Acre	Tons Cane per Acre	Lbs. Sucrose per Acre
1	34.0	8,873	27.3	5,797
2	38.4	8,790	32.0	6,521
3	29.4	6,322	31.2	6,360
4	30.7	5,756	18.3	3,524
5	25.0	5,107	32.0	6,659
Average	31.5	6,969	28.1	5,772

TABLE X

COMPARATIVE YIELDS FROM SC-12(4) AND CRISTALINA IN GUANTANAMO, CUBA

Variety	Tons Cane per Acre	Brix.	Purity
S. C. 12 (4)	60	17.90	82.45
Cristalina	37	17.48	82.13

TABLE XI

SOME SOUTH COAST RESULTS FOR PORTO RICO

CROP OF 1923

	Acres		Tons cane per acre	Tons cane per acre	
S. C. 12(4)	32 00	Prim.	26.83	3.57	
B. H. 10(12)	263.90	Prim.	21.99	3.03	
S. C. 12(4)	104.00	G. C.	45.11	3.57	
B. H. 10(12)	156.00	G. C.	45.46	5.82	
S C 12(4)	6.00	G C.	60 01	7.12	Planted after cow-peas
B H. 10(12)	12.00	G C.	61.70	7 65	
S. C. 12(4)	3 50	G. C.	50.48	6 36	
B. H 10(12)	81 00	G C	50.25	6 06	
S. C. 12(4)	11.00	G C.	56.14	6 82	
B. H 10(12)	11.50	G. C	52 17	6 50	
S. C. 12(4)	10.60	G. C.	70.67	8 86	
B. H. 10(12)	8 50	G. C.	80.76	10 46	

CROP OF 1924

S. C. 12(4)	58 00	Prim.	31.34	4.25	
B. H. 10(12)	476 00	Prim.	29.78	4.06	
S. C 12(4)	116 00	G C.	34.97	3 98	
B H. 10(12)	399.00	G C.	37.90	4.78	
S. C. 12(4)	2.75	G. C.	80.21	8 62	
B. H. 10(12)	7 00	G. C.	69.54	8.45	

CROP OF 1925

S. C. 12(4)	28.00	G. C.	70.11	9.02	
B. H. 10(12)	21 50	G. C.	92.49	11.58	
S. C 12(4)	11.25	Ratoon	38 32	5 08	
B. H. 10(12)	17 75	Ratoon	30 28	4 25	

TABLE XII

SANTA RITA EXPERIMENTS WITH D-117, BH-10(12) AND SC-12(4)

Variety	Plat No.	Tons Cane	Tons Per Acre 96 Sugar	Sucrose	Purity
D-117	1	67 68	4 89	9.82	72 8[illegible]
B H. 10 (12)	2	66 44	6.16	11.95	78.71
S. C 12 (4)	3	76.51	6 74	11.52	76.82

TABLE XIII

BH-10(12) COMPARED WITH RAYADA AT CENTRAL "LOS CAÑOS"

Date	B H 10 (12) Gran Cultura		Rayada Ratoons	
	Sucrose	Purity	Sucrose	Purity
III-29-24	14 95	83 50	16.50	86.01
31-24	14.60	84.19	16 58	89.22

TABLE XIV

CAÑO TIBURONES EXPERIMENT

Variety	Tons Cane per Acre	Sucrose	Purity
Rayada	34.34	15.08	90.81
D-117	32.40	13.15	81.67
Cristalina	36 00	15.48	89.22
Caledonia	39.78	13.04	81.42
S. C. 12 (4)	42.85	15 94	90.10

TABLE XI

ARECIBO RIVER EXPERIMENT

Variety	Tons per acre
D-109	43. 33
D-117	43. 75
B-208	43. 33
S.C.-12(4)	50. 95
B.H.-10(12)	50. 00

TABLE XVI

COMPARATIVE FACTORY YIELDS OF SC-12(4) AND RAYADA AT CENTRAL VICTORIA

Variety	Kind of Cane	Age (Months)	Class of Soil	Month Cut	Factory Yield
S. C 12 (4)	Primav.	11	High and dry	End Feb.	14.97
Rayada	Primav	10	High and dry	Early Apr	13 16
S. C. 12 (4)	Primav.	12	High and dry	End Feb	13.61
Rayada	Primav.	13	High and dry	End Feb.	13.16
S. C. 12 (4)	Gr. Cul	15-16	Low and wet	January	11.34
Rayada	Gr Cul.	15-16	Low and wet	January	10.91
S. C 12 (4)	Gr Cul.	15-16	Low and wet	January	10.82
Rayada	Gr Cul	15-16	Low and wet	January	10.66

TABLE XVII

SC-12(4) AT CENTRAL SANTA JUANA

Date	Net Weight of Cane	Crusher Juice		Factory Yield		Sugar to
		Sucrose	Purity	Total	Colono	Colono
IV-29	30,009	18 01	91.5	13 84	8.67	2,602
IV-29	22,400	18 18	91 8	13.44	8.74	1,958
IV-30	27 940	19 68	93.7	14.72	9.57	2,674
IV-30	34,520	19 64	93.0	14,66	9 54	3,293
V-1	28,640	20 19	93 4	15 20	9.88	2,830
V-1	29,020	19 49	92 8	14 59	9.48	2.751
V-2	31,100	18 11	91.4	13 40	8.71	2,708
V-2	27,180	19.90	95 2	15.04	9.78	2,658
V-4	30,120	19.97	94.1	15.05	9.78	2,941
V-5	31,040	20.16	95.0	15.23	9 90	3,073
V-5	34,980	20.43	94 5	15.37	9.99	3,495
V-5	32,380	20.12	94.4	15.18	9.87	3,196

For details regarding these figures, see the writer's report on these canes.

REFERENCES

ROSENFELD, ARTHUR H.—The BH-10(12) and SC-12/4 Canes. Jour. Dept. Agr. of Porto Rico, IX, 3, pp. 215–47; July, 1925.

SMITH, LONGFIELD.—Rept. of the Virgin Island Expt. Sta. 1919.

St. Croix-12(11).

Probably imported by the Mayagüez Station. Central Mercedita planted 3 acres in the fall of 1920.

Not seen, except by the writer in St. Croix in 1923, where it did not look at all promising.

REFERENCES

SMITH, LONGFIELD.—Report of the Virgin Islands Agr. Expt. Sta., 1919, p. 9.

Idem.—*Ibid*, 1920, p. 8.

SC-22(21).

Seedling of SC-12/4. Sent to the author in November, 1925, by Mr. Maybin S. Baker, Agronomist of the Federal Agricultural Experiment Station in St. Croix Virgin Island. A laboratory test of this cane at the St. Croix Station in that month, the cane being but nine months of age, showed it to have more sucrose and less glucose than the ordinary canes there at the same time. During the extreme drought in St. Croix in 1925 this variety did not suffer as much as the other canes at that Station. In appearance SC-22(21) resembles SC-12/4.

Erect, then recumbent, fair vigor, light stooler, very suceptible to mosaic. Stalks long and of good girth, yellowish-green, flushing

heavily on exposure to sun, heavy bloom. Internodes medium to long, appressed at sides, enlarged at base, slightly staggered; furrow long, broad and shallow, at times wanting, inconspicuous. Nodes constricted, oblique; growth-ring broad, 4 to 6 mm., elevated, yellowish-brown to concolorous; root-band medium width, covered with white wax; rudimentary roots few, small and scattered in rows 3 to 4, inconspicuous; leaf scar glabrate, appressed behind; glaucous band broad, constricted and inconspicuous. Buds medium to large, 7 by 10 mm., orbicular, plump, tendency to early swelling, reaching growth-ring, germination apical, margins none; short, broad apical tuft and light basal placs. Leaf sheaths with heavy vestiture of short, tawny, deciduous hairs at back, sides glabrate, glaucous, slightly tinted without, green at base within; throat broad, dark, lannated with short wooly hairs, some straggling hairs at sides; collar broad, reaching midrib, dark, gray, heavily glaucous, lannated with very short, velvety hairs; ligule narrow, 2 to 4 mm., at sides, becoming wide and peaked at center; no ligular process. Leaf blades erect with declining tips, wide, 8 to 9 cms., bluish-green color, not flat, prominent white midrib, uniformly and minutely serrulated and ciliated to base.

REFERENCES

BAKER, MAYBIN S.—Report of the Agronomist. Rept. of the Virg. Is. Agr. Experiment Station, 1924.
Idem.—Ibid, 1925.

St. Kitts Seedling.

Imported by Mr. Sewall from Antigua in 1911. Said to be a sport from B–208. Mr. Sewall notes that here it reverts to that kind, although we have not yet observed this to be the case at the Station. It was reintroduced to the Station, after having disappeared from cultivation, by Mr. Julius Matz, direct from St. Kitts, in 1922. At the Station it has grown and given results about like B–208, but at the "Los Caños" substation, while not showing up as one of the best of the score of canes being tried there, it is far ahead of B–208, which is the worst attacked variety with mosaic disease. The St. Kitts Seedling seems very much more resistant to this disease than does B–208, although it takes it readily. It occasionally tassels, but is not a great sinner in this respect.

Erect, at length recumbent, good vigor and good stooler. Stalks long and of good girth, yellow basal color, with heavy bloom, flushing to pinkish-brown on exposure to sun. Internodes medium length, slightly tumid and appressed at sides, slightly staggered; furrow short, broad and shallow. Nodes nearly even and oblique; growth-

ring narrow, 2 to 4 mm., even and inconspicuous, concolorous; root-band narrow, oblique, heavy white waxy deposit, concolorous; rudimentary roots very small, few and scattered, 2 to 3 in rows, purplish; leaf scar glabrate, very broad and prominent in front, forming a distinct lip, covering base of bud, appressed behind; glaucous band oblique, sunken and narrow in front, becoming broader and shallow towards back of bud, inconspicuous. Buds large, 10 by 12 mm., plump, exceeding growth-ring by one-third, orbicular, germination sub-apical, margins broad, flat, lannated, winged above and shouldered near base, no apical tuft, light basal placa, lannation along fibro-vascular bundles of scales. Leaf sheaths with scanty dorsal vestiture, sides glabrate, glaucous, green; throat very broad, brownish and distinctly lannated with short appressed hairs, long straggling marginal hairs; collar broad and reaching midrib, lannated, with velvety hairs; ligule medium width to broad, 4 to 5 mm., slightly elevated at center; ligular process short and stubby, on one side only Leaf blades drooping, broad, 10 to 12 cms., dark green minutely and uniformly serrulated at margins, some basal ciliation.

Variety	Date	Extract	Brix	Sucrose	Purity	Location	Fiber	Age
54 Kitts Seedling	IV 11 24	64 10	20 85	19 61	94 05	Ins Sta	12 77	Ratoons
B H 10 (12)	IV 11 24	70 00	24 20	23 20	96 26	Ins Sta	10 74	Ratoons

* **Salangor.**

(= Salangor Blanca.) Introduced by Dr. Grivot Grand-Court, probably from Guadaloupe, prior to 1879. Regarded by Dr. Stahl as a variety of great importance, since he considered it very resistant to the prevailing epidemic. This cane was until recently grown in pure cultures at Central Coloso, where fields of several acres were examined by Earle which showed a cultural value and general vigor fully equal to Rayada. It has been found nowhere else on the Island.

Erect but often soon declined, vigorous, seldom or never arrows. Stalks long, medium stout, pallid or yellowish, no flush, very heavy bloom, often marked with faint brownish lines that are obscured by the bloom. Internodes medium length, straight, barrel shaped, furrow faint or none. Nodes constricted; growth ring inconspicuous, poorly marked, concolorous; root band narrow, less than 10 mm., at first whitish then greenish; rudimentary root numerous, crowded, small, purplish, in about 4 irregular rows: leaf scar glabrous, somewhat oblique, appressed behind; glaucous band obscured by the heavy bloom. Buds ovate-acuminate, rather large, about 10 × 15

mm., exceeding the growth ring by one-third or more of the length, often purplish, germination subapical, margin uniform, rather broad, glabrous except for a heavy tuft of long, curled hairs on either side above the base. Leaf sheath with an abundant vestiture of short, suberect, rather weak, pallid hairs, strongly glaucous, pallid greenish, purplish at base within; throat dark brown, densely lannate and with a fringe of long hairs behind the ligule and at the sides; collar conspicuous, reaching the midrib, dark brown, reddish brown when young, glaucous but not lannate; ligule medium; ligular processes none or short and inconspicuous. Leaf blades spreading, light green, flat, 5 to 6 cm., wide, minutely but distinctly serrulate, the base ciliate.

This cane was so highly endorsed on its introduction and presents such a good appearance wherever grown that it seems very strange that it has been so little planted. Apparently it is better adapted to *vega* lands than to the hills, thus being complementary to the last, which was clearly a hill-land cane. It is reported as a sweet, good milling cane but no analyses are available. It has proved to be quite susceptible to mosaic but its reactions to root disease and gum disease have not been determined. It is clearly worthy of a much more extended trial than has ever been given it in this Island. It is one of the old, well-known varieties with a long history in the literature. It is usually considered as = Penang but it is absolutely distinct from the kind so named here.

Salangor Rayada.

This name is used by Stahl, and according to López Tuero seems to = Rayada, though of this it is impossible to be fully certain. A variant of the above variety was, however, observed by Earle in the fields at Central Coloso which may properly be called Salangor Rayada. It has faint white and green stripings on the stalks.

Salangor Rojo.

As used by Stahl and López Tuero, this name clearly stands for what is here called Cavengerie Rojo, which see. The cane brought in from Bayaney by Earle under this name has, as already stated, proved to be what is here called Rosa Morada.

Sarangola.

A local name occasionally heard in Porto Rico. Sometimes it is applied to Cristalina and once Earle found it applied to Rosa Morada. It does not occur in the literature.

*** Sealey Seedling.**

Introduced by Mr. Sewall from Antigua in 1909. At various

times it has been considerably planted at both Central Fajardo and Guánica. Occasionally found in mixed plantings in other parts of the Island. As grown here it is scarcely distinguishable from B–3412. In the former paper on cane varieties by Mr. Earle it was considered as identical, but perhaps the point is not fully proven.

Erect or at length decumbent, vigorous, free stooling, arrowing only in certain localities. Stalks long, slender, usually 2½ to 3 cm., though sometimes thicker, green with strong reddish flush when fully exposed, bloom light but usually evident. Internodes medium to long, often slightly staggered, compressed laterally, furrow well marked. Nodes slightly constricted, oblique; growth ring inconspicuous, usually slightly sunken, 2 to 3 mm. wide, concolorous; root band oblique, 6 to 10 mm., concolorous, rudimentary roots slightly sunken, inconspicuous with very small, purplish center, in 3 to 4 rows; leaf scar glabrous, appressed behind; glaucous band conspicuous, 8 to 10 mm., scarcely constricted. Buds rather large, ovate, rather obtuse, about 13 × 13 mm., exceeding the growth ring by one-third of length. Margin broader below but not shouldered, about 1 to 1½ mm., germination apical, the base with placs of heavy crisped hairs, margin and apex bearded. Leaf sheaths with heavy vestiture of short, stiff assurgent hairs, green, not much glaucous; throat lannate and with long hairs behind the ligule; collar broad, rather conspicuous, glaucous but not lannate, ligule, 3 to 4 mm. at center tapering to 1 mm. at ends, the edge fimbriate; ligular process none. Leaf blades spreading, more or less in two ranks, crowded, narrow, usually averaging but little more than 5 cm., bright green, minutely but sharply serrulate, the base nearly even.

As here described this differs from B–3412 in the more strongly lannate throat and from B–3405 in the glaucous collar. The leaves, too, seem to average a little narrower, but it is by no means certain that these differences are constant. The material we have under these three names is scarcely distinguishable either by cultural or taxonomic characters. We have no real proof that these names are authentic, or if by chance only one kind has really reached us under these three names which one of the three really represents.

Whatever these facts may be it is a vigorous, strong ratooning cane which gives heavy tonnage under a variety of soil conditions. It is late in maturing and should only be planted as *gran cultura*, since when immature it is very low in sugar. For the same reason it is best planted on uplands, for on low, wet soils it seldom really matures. At 15 to 16 months, if fully ripened by 6 to 8 weeks of dry weather, it developes a high degree of sucrose and purity.

Comparatively few analyses are available under this name, but the following will illustrate what may be expected when green and when fairly well matured:

Kind	Date	Age	Extr	Brix	Sucr.	R. S.	Purity	Fiber
Sealey S	1-12-12	....	.. .	14 8	10.6	2.2	71 6	.. ....
Sealey S	12-15-20	Rat 14 mo .	69 6	14.59	11.59	2.49	79 76	13.5
Cristalina	12 15-20	Rat 14 mo ..	70.0	17.58	15.58	0 28	88 74	9.60
Sealey S. (1)	1-24-21	Rat 15 mo .	70 1	14 47	10 87	1.88	75 47	13.11
Cristalina ...	1-24-21	Rat 15 mo .	70 8	17.85	16.14	0.28	90 42	10.69
Sealey S. (2)	2-26 21	. ...	. . .	19 70	17.85	....	90 60	....

(1) Still green
(2) Getting ripe

This is a kind that may give very profitable results if planted in pure cultures and harvested with good judgement, but it is clearly unwise to let it become mixed with other kinds where it is likely to be cut while containing only 10 or 11 per cent of sugar in the juice.

Its strong resistance to root disease and good ratooning powers are its chief advantages. It is quite susceptible to mosaic and suffers badly when attacked. Its reaction to gum disease has not been determined. Its further planting is recommended to those who will study its peculiarities. Those who will not had better follow Earle's advice and leave it alone.

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WATTS, FRANCIS—Sugar-Cane Experiments in the Leeward Islands in the Season 1919–20.—Pt. I, Expts. with Varieties. Issued by the Commissioner of Agriculture for the West Indies, 1921.

* Tamarin.

Introduced by Dr. Grivot Grand-Court, probably from Guadaloupe, prior to 1879. The name originated in Mauritius. The cane is said to come from New Caledonia. Found sparingly in mixed plantings in the hills between Arecibo and Lares. Not seen elsewhere.

Erect at length decumbent, of medium vigor, arrowing not observed. Stalks of medium length and diameter dark purple, with moderate bloom. Internodes medium length, barrel shaped, furrow none. Nodes strongly constricted; growth ring wide, 3 to 4 mm., somewhat sunken, yellow then concolorous or darker; root band about

8 mm., concolorous, rudimentary roots with dark purple centers, in 3 to 4 rows; leaf scar glabrous, appressed behind; glaucous band constricted, about 8 mm., conspicuous. Buds ovate, 8 to 9 $\times$ 10 mm., somewhat exceeding the growth ring, margin medium width, uniform, germination subapical, basal place of crisped hairs extending onto the margins, apex glabrous. Leaf sheaths with medium vestiture, glaucous, tinted, the base within stained purple; throat nearly glabrous with a few long marginal hairs; collar broad, pallid, not reaching the midrib, glaucous; ligule broad, 5 mm., fimbriate, ligular processes on only one side, broad and short, the edge fimbriate. Leaf blades spreading, bright green, 5½ to 6½ cm. wide, very minutely serrulate, the base ciliate.

Only seen on hill lands, where it is of only moderate vigor. It is susceptible to mosaic; behavior to other diseases not observed. It is a soft cane and reported to be very sweet, being much sought by the laborers for chewing. No analyses are available. Its agricultural value is problematical.

Tanna.

Canes called Black Tanna were cultivated on the Station grounds in 1913. The seed was brought in from nearby fields. From the descriptions on file they seem to have been the selft-colored forms of Cavengerie, here called respectively Cavengerie Roja and Cavengerie Negra.

In the spring of 1920 seeds of striped Tanna were sent to this Station by Director May of the Federal Station, who imported them from Guadaloupe. Unfortunately, they failed to grow. The variety is, however, growing in the plots of the Station at Mayagüez.

Toledo.

Parentage totally unknown. Found by Brandes growing on Toledo Plantation in the Philippine Islands and given this name by him. It is evidently an adventitious cross of Negros Purple or some other noble cane with a Chinese or North Indian cane, as it is very similar in general appearance to the P.O.J. series from Java. Brandes reported it as immune to Mosaic when first imported, but on 3rd April, 1926, Mr. Luis Serrano rogued two infected stools from a planting of this variety in a hillside tonnage experiment at the Station, so, as with so many other varieties hitherto considered immune, Toledo can now be called only highly resistant.

Erect, good vigor and good stooler. Stalks long and excessively thin, purple, heavy grayish bloom. Internodes medium to long, tapering perpendicular to stalk; furrow from triangular flattening

to none. Nodes elevated and oblique; growth-ring narrow, 2 to 4 mm., slightly elevated, green to concolorous; root-band narrow, oblique, green to concolorous; rudimentary roots few, scattered, in rows 2 to 3, purple, conspicuous; leaf scar glabrate, appressed behind; glaucous band broad, tapering, inconspicuous. Buds medium size, 7 by 9 mm., ovate, reaching growth-ring, germination apical, margins narrow and intended at apex, flat, glabrous, no apical tuft or basal placs. Leaf sheaths closely adhering, with abundant vestiture of tawny, deciduous hairs at back, sides glabrate, glaucous, slightly tinted at base within and out; throat narrow, dark very scanty vestiture of short, wooly hairs, few coarse straggling hairs at sides; collar narrow, glaucous, reaching midrib; ligule narrow, 2 to 4 mm., becoming wide and peaked at center, ciliated on upper margins; ligular process on one side only, spur-shaped. Leaf blades spreading, narrow, about 4 cms., dark green with pronounced white midrib, uniformly serrulated and ciliated to base.

No field or factory data are as yet available, as this variety was obtained from Dr. Brandes only in January, 1925, by Commissioner of Agriculture Carlos E. Chardón, although, due to its rapid development, we were able to multiply from these two original seed-pieces enough cane to plant out a tonnage experiment with this variety in comparison with ten canes of the Chinese type in November of the same year.

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Brandès, E. W.—Mosaic's Role in Limiting Louisiana's Yield. Facts abt. Sugar, 28th June, 1924.

Hind, R. Renton.—Toledo Cane, a Mosaic-Immune Variety. Phil. Sug Cent. and Plants Noiks, XV, 3 pp. 105–1013.

T-77.

Imported from Audubon Park, Louisiana, in 1904 by the Mayagüez Station. This cane was considerably planted at Guánica, 1910 to 1912, and was tested by Sewall at Naguabo, who got his seed from the Mayagüez Station. It was in cultivation at this Station from 1911 to 1913. In the Aguirre variety tests in 1911 it gave, tons cane, 61.42; brix, 19.19; sucrose, 15.85; purity, 82.6; tons sugar, 6.95. In 1912 at this Station it gave, brix, 17.2; sucrose, 14.6; glucose, 1.4; purity, 84.9; and in 1913 ratoon 12 months, brix, 17.01; sucrose, 15.07; purity, 88.6. Mr. Sewall reports February 25, 1912, brix, 17.10; sucrose, 15.70; purity, 91.8. It is described as a rather slender red cane.

Not seen.

THE TUCUMÁN SEEDLINGS

Bred by Mr. G. L. Fawcett, Botanist and Plant Pathologist of the Agricultural Experiment Station in Tucumán, Argentina, who, with Dr. Cross, the Director, have been kind enough to send us quite a good series of these canes. All that we have are very thin, heavily stooling types, showing Chinese or P.O.J. ancestry and most of them seem almost immune to mosaic disease and root troubles. Five of them have been planted out in tonnage experiments at the Station, where they are making good development, and four of them in substations under hill conditions at Bayaney and on good *vega* land at "Los Caños". In both substations they are making enormous growth. We know nothing of their sugar content as yet and Mr. Fawcett's reports so far are not very encouraging.

REFERENCES

CROSS, W. E.—Las Cañas "Tucumanas". Revista Industrial y Agrícola de Tuc., VIII, pp. 251–55; 1918.

Idem.—Las Cañas Tucumanas en la Cosecha de 1919. *Ibid,* IX, pp. 161–7; 1919.

Tuc-439.

Imported in July, 1924.

Erect, fine vigor, stools prolifically. Stalks long and slender, rosy purple in color, heavy and uniform bloom. Internodes long, cylindrical but slightly enlarged at base, not staggered, furrow inconspicuous, concolorous, narrow and deep. Nodes slightly constricted, oblique, growth ring broad, prominent and oblique, green becoming concolorous; root band narrow, oblique, yellowish green to concolorous; rudimentary roots few and scattered, 2–3 in row, purplish to concolorous; leaf scar glabrate, broad and prominent in front and appressed behind; glaucous band inconspicuous, constricted in front and even behind. Buds small to medium, 8 × 10 mm., reaching growth ring, orbicular, germination subdorsal, margins broad and flat on upper part only, shouldering abruptly and giving bud a distinct urn-shaped appearance, slightly lannate, no basal places. Leaf sheaths almost glabrate, with few scattered dorsal basal hairs, no wax, purple when young, older sheaths tinted, inner base heavily tinted with purple; throat medium width and sparsely lannate, with long straggling hairs at margins; collar narrow, inconspicuous, reaching midrib, glaucous; ligule wide, 4–6 mm., nearly even; ligular process broad and long, on one side only, deciduos. Leaf blades spreading with declining tips, medium width, 6–7 cms., dark green, margins uniformly serrated, some basal ciliation.

This variety, while very thin and having the defect that the leaf-sheaths adhere very tenaciously to the stalk as in the case of Uba, is making remarkable stools in the tonnage experiments at the Station and in the substation at Bayaney.

Tuc-444.

Received from Dr. W. E. Cross, Director of the Experiment Station in Tucumán, Argentina, in October, 1925, and planted out for extension. No data are as yet available as to its behavior anywhere.

Erect and then recumbent, good vigor and stooling qualities. Stalks long and thin, green and overlaid with roseate flush, heavy bloom. Internodes long, cylindrical, slightly staggered, no furrow. Nodes prominent, parallel; growth-ring narrow, 2 to 4 mm., even, inconspicuous, brownish to concolorous; root-band narrow, bulging, yellowish-green to concolorous, covered with reddish wax; rudimentary roots large, few and scattered, in rows 2 to 3, purplish to brown, tendency to premature sprouting; leaf scar glabrate and appressed behind; glaucous band broad, tapering, inconspicuous. Buds small to medium, 6 by 8 mm., oval, reaching growth-ring, germination subdorsal, margins very narrow, on upper half only, sparsely lannated, no apical tuft or basal placs. Leaf sheaths with sparse vestiture of tawny hairs at back, sides glabrate, glaucous, green outside and slightly tinted on inner base; throat broad, dark colored, covered with short appressed hairs, some straggling coarse hairs at margins, tendence to split at sides; collar broad, glaucous, dark, reaching midrib; ligule narrow at sides, 2 to 4 mm., abruptly widening at center, nearly even on upper border; ligular process none. Leaf blades spreading, narrow, 4 to 5 cms., dark green, serrulated and ciliated to base.

Tuc-454.

Received from Dr. W. E. Cross, Director of the Experiment Station in Tucumán, Argentina, in October, 1925, and planted out for extension. No data are as yet available as to its behavior anywhere.

Erect, good vigor and stooling qualities. Stalks long and excessively thin, general appearance and color of Uba. Internodes long, tapering, perpendicular to stalk, no furrow. Nodes prominent and parallel; growth-ring narrow, 2 to 4 mm., slightly elevated, brownish to concolorous; root-band wide, bulging, yellowish-green to concolorous; rudimentary roots small, few and scattered, inconspicuous, in rows 2 to 3, purple to concolorous; leaf scar glabrate, appressed behind, lipped in front; glaucous band broad, tapering except at front where it is constricted, indistinct. Buds small, 5 by 7 mm., oval, reaching growth-ring, germination sub-apical, margins broad

and flat, on upper half only, glabrous, no apical tuft or basal placs. Leaf sheaths closely adhering, glabrate, glaucous, green; throat narrow, dark gray, lannated with short wooly hairs, coarse straggling hairs at margins; collar narrow, dark, reaching midrib, glaucous; ligule narrow at sides, becoming abruptly wider and peaked at center; ligular process long and thin on one side only, 2 to 3 cms. Leaf blades spreading, narrow, 4 to 5 cms., dark green, serrulated except at base, scant basal ciliation.

Tuc-472.

Received from Mr. George L. Fawcett, Botanist of the Tucumán Experiment Station, in July, 1925, and planted out for extension. Is making a most vigorous growth and will be planted out in tonnage experiment this fall. Nothing yet known as to its sucrose yield.

Erect, good vigor and good stooler. Stalks long and excessively thin, dark purple, heavy bloom. Internodes exceptionally long, as with kassoer cylindrical, perpendicular to stalk, characteristic long, flat, wide furrow, extending almost entire length of internode. Nodes somewhat elevated, parallel; growth-ring narrow, 2 to 4 mm., nearly even, brownish to concolorous; root-band narrow, slightly bulging, covered with reddish wax; rudimentary roots large, few and scattered, in rows 3 to 4 purplish, elevated; leaf scar glabrate and appressed behind; glaucous band broad, tapering and inconspicuous. Buds small, 5 by 7 mm., ovate, reaching growth-ring, germination apical, margins narrow, uniform, on upper half only, nearly glabrate, no apical tuft, light basal placs. Leaf sheaths closely adhering, glabrate, tinted within and without, no wax; throat narrow, brownish, covered with short velvety hairs, coarse, long and straggling hairs at margins; collar narrow, reaching midrib, glaucous; ligule narrow at sides, becoming very wide and peaked at center, ciliated on upper border; ligular process on one side only, lanceolate, long. Leaf blades spreading, narrow, about 4 cms., dark green, minutely and uniformly serrulated and ciliated.

Tuc-491.

Imported in July, 1924.

Erect, later recumbent, fine vigor, stools prolifically. Stalks long and slender, basal yellow color, heavily overlaid with rustly purple striations, heavy bloom. Internodes long, cylindrical, not staggered, some tendency to spliting, no furrow. Nodes, enlarged, oblique growth ring narrow and inconspicuous, even yellow to concolorous; root band wide, oblique, prominent, yellow to concolorous; rudimentary roots few and scattered, 3–4 in a row, purple; leaf scar glab-

rate, appressed behind; glaucous band inconspicuous and tapering. Buds small and plump, 6 × 8 mm., reaching growth ring, orbicular, germination subdorsal, margins none, scanty upper vestiture of short hairs, no basal place. Leaf sheaths almost glabrate, with very few scattered dorsal basal hairs, green, slightly glaucous, inner base slightly tinted with purple; throat narrow and covered with velvety hairs, coarse hairs at margins; collar narrow, reaching midrib, glaucous; ligule medium width, abruptly enlarged at center; ligular process none. Leaf blades spreading with declining tips, narrow, 4–5 cms., dark green, upper margins extremely minutely serrulated, no basal ciliation.

In the Station tonnage experiments and in the *vega* substation at "Los Caños", this variety is looking particularly well and is the stoutest and best looking in general of all the Tucumán seedlings we have. It has the general appearance of P.O.J. seedling.

Tuc-507.

Obtained from Dr. Cross in July, 1924. Is making vigorous growth and magnificent stools in Station tonnage experiments and at hill-land substation at Bayaney, under the charge of Mr. A. M. Quintero. No data as yet available as to sugar content, either in the Argentine or here. One objectionable feature of this variety is the abundance of long, spiny hairs at back of leaf sheath—particularly in a variety of such closely-adherent leaf sheaths as is this.

Recumbent, fine vigor, stools prolifically. Stalks long and exceedingly thin, wine color, heavy bloom. Internodes long, cylindrical and staggered, no furrow. Nodes almost even, oblique; growth ring narrow and inconspicuous, even, yellowish green, becoming concolorous; root band narrow, oblique, yellow becoming concolorous; rudimentary roots few and scattered, 2–3 in rows, purplish to concolorous; leaf scar lannate, appressed behind; glaucous band inconspicuous, tapering. Bud small, 6 × 8 mm., reaching growth ring, orbicular, germination dorsal, margins flat and abruptly shouldered above, giving distinct urn-shaped appearance to bud, very characteristic wide apical tufts of long straight hairs, no basal place. Leaf sheaths abundantly and uniformly covered with long tawny hairs, green inner base slightly tinted with purple; throat wide and lannate, with long straggling hairs at margins; collar wide, reaching midrib, glaucous; ligule medium width, 3–5 mm., nearly even; ligular process none. Leaf blades spreading with declining tips, narrow, 4–5 cms., dark green, margins serrated almost to base, extremely sparse basal ciliation.

Tuc-510.

Similar to Tuc.–507 in general appearance and type of growth. Is developing spendidly in Station tonnage experiments and at the "Los Caños" substation, in charge of Mr. Antonio Fraticelli. This cane lacks the objectionable spines so noticeable on back of leaf sheath of Tuc.–507. No chemical data are available on this cane, either in the Argentine or in Porto Rico, as the first tonnage experiments were planted out only in the fall of 1925.

Erect, fine vigor, stools prolifically. Stalks long and excessively slender, yellow base overlaid with grayish purple bloom. Internodes long, cylindrical, slightly staggered, furrow broad, flat and inconspicuous to none. Nodes almost even; growth ring narrow, slightly elevated, yellow to concolorous; root band narrow and prominent, oblique, yellow; rudimentary roots few and scattered, 2–3 in rows, inconspicuous, concolorus; leaf scar glabrate, appressed behind; glaucous band inconspicuous, constricted under bud and even at back. Buds small and plump, 5 × 7 mm., not exceeding growth ring, orbicular, germination dorsal, margin broad and flat above, abruptly shouldered laterally, glabrate. Leaf sheaths closely adherent, glabrate, no wax, inner base very lightly tinted with purple; throat narrow and inconspicuous almost glabrate; collar medium width, reaching midrib, glaucous; ligule broad and fringed; ligular process none. Leaf blades spreading declining tips, narrow, 4–5 cms., dark green, very minutely serrulated, very sparse basal ciliation.

Tuc–511.

Received from Director Cross, of the Tucumán Experiment Station, in October, 1925, and panted out for extension. Making rapid development and can be planted out to tonnage experiments this fall. No data as yet available anywhere as to value as sucrose producer.

Erect, fine vigor, excellent stooler. Stalks long and thin, rose colored to purple, heavy bloom. Internodes long, cylindrical, perpendicular to stalk, furrow none. Nodes prominent and oblique; growth-ring, narrow, 2 to 4 mm., even, green to concolorous; root-band narrow, light green through pink to concolorous, somewhat elevated, covered with abundant bloom; rudimentary roots few, large and scattered, in rows 3 to 4, purple to brown; leaf scar glabrate, appressed behind; glaucous band broad, tapering, inconspicuous. Buds small to medium, 6 by 8 mm., ovate, at times exceeding growth-ring, germination apical, margins flat, narrow, uniform and on upper two-thirds only, sub-glabrate, no apical tuft, extremely light basal place. Leaf sheaths rather closely adhering, glabrate, tinted within

and without; throat narrow, dark colored, lanuated with long silky hairs protruding from margins; collar narrow, glaucous, lanuated, with velvety hairs, reaching midrib; ligule narrow at sides, 2 to 4 mm., widening at center, fimbriate; ligular process on one side only, long and narrow, about 2 cms. Leaf blades spreading narrow, 4 to 5 cms., dark green, minutely serrulated and ciliated to base.

Tuc-531.

Received from Director Cross, of the Tucumán Experiment Station, in October, 1925, and planted out for extension. Making rapid development and can be planted out to tonnage experiments this fall. No data as yet available anywhere as to value as sucrose producer.

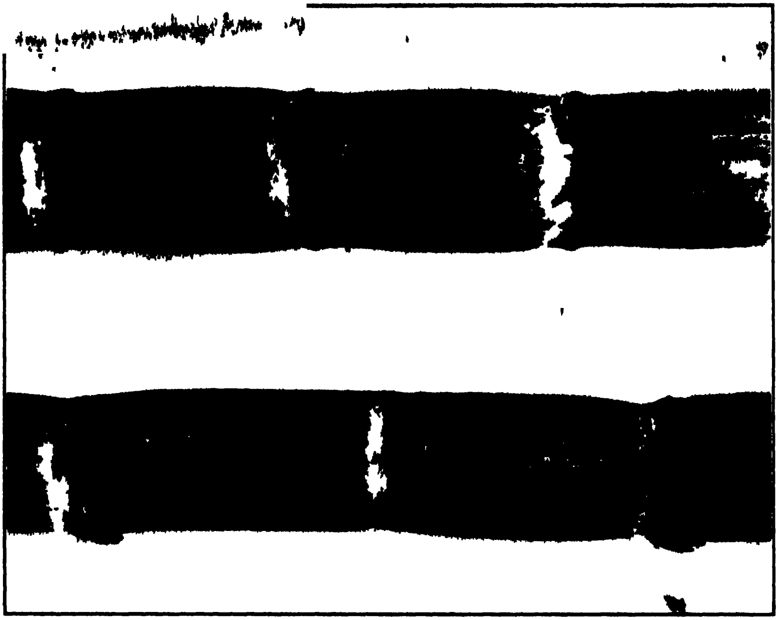
Erect then recumbent, good vigor, fine stooler. Stalks long and excessively slender, purple with heavy wax deposit. Internodes long, cylindrical, perpendicular to stalk, no furrow. Nodes elevated and parallel; growth-ring wide, 4 to 6 mm., even, yellowish-green to concolorous; root-band wide, elevated, yellowish-green to concolorous; rudimentary roots few, large and scattered, in rows 3 to 5, dark purple; leaf scar glabrate, appressed behind; glaucous band, tapering, broad and inconspicuous. Buds small, 5 by 7 mm., oval, plump, reaching growth-ring, germination sub-apical, margins narrow and on upper half only, sub-glabrate, with a very few short hairs, no apical tuft or basal placs. Leaf sheaths closely adhering, heavy vestiture of long, tawny hairs at back, sides glabrate, slightly tinted within and without; throat narrow, dark gray, covered with short, coarse hairs, tendency to split at sides; collar narrow, reaching midrib, glaucous, covered with short wooly hairs; ligule narrow at sides, becoming wide and peaked at center, undulating border; no ligular process. Leaf blades spreading, narrow, about 6 cms., dark green, noticeable white midrib, margins almost smooth, no basal ciliation.

Tuc-544.

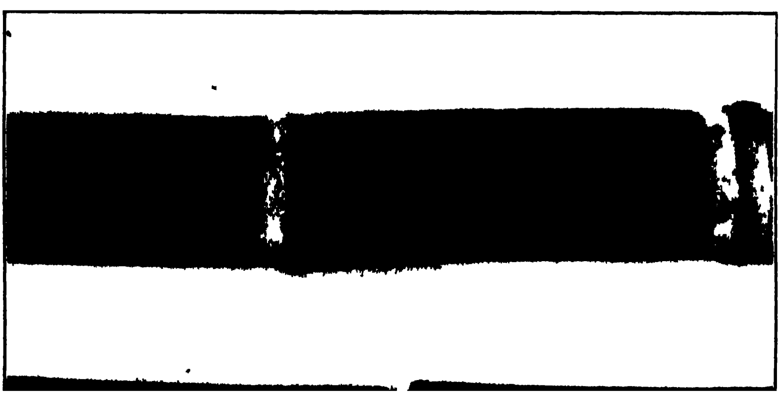
One of the original lot of five Tucumán seedlings sent by Dr. W. E. Cross from the Tucumán Experiment Station in July, 1924, and the one which has shown up poorest of the lot. It is an excessively slender red cane of very little promise either as plant or stubble, with a very pronounced tendency to premature sprouting. It has, however, been planted out in tonnage experiments with its sister canes and Kassoer and after the crop next spring we shall know more definitely of the qualities as a cane and sugar producer of Tuc.-544.

Spreading, good vigor, fine stooler. Stalks long and excessively slender, wine colored with grayish bloom. Internodes long, cylindrical, perpendicular to stalk, no furrow. Nodes prominent, parallel

PLATE XXVII



RAYADA



YELLOW CALEDO

growth-ring broad, 4 to 6 mm., yellowish-green to concolorous, nearly even; root-band medium width, bulging, yellowish-green to concolorous; rudimentary roots large, few and scattered, in rows 2 to 3, purplish, marked tendency to premature sprouting; leaf scar glabrate, appressed behind; glaucous band broad, tapering, indistinct. Buds small and plump, five by seven mm., ovate, reaching growth-ring, germination sub-apical, margins medium width, on upper half only, uniform, very lightly lannated, short and light apical tuft, no basal places. Leaf sheaths with heavy vestiture of coarse hairs at back, sides glabrate, purplish to red outside, tinted purple at base within; throat broad, dark, lannated with short woolly hairs, long straggling hairs at margins; collar broad, heavily covered with white wax deposit, reaching midrib; ligule narrow at sides, 2 to 4 mm., widening abruptly and becoming peaked at center; rudimentary ligular process on one side only. Leaf blades spreading, narrow, about 4 cms., dark green, serrated except at base, where there is scanty ciliation.

Verde Zic-Zac.

Stahl, p. 137:

"I will so call a certain green cane whose joints form a zig-zag until I know its true name. It is superior in sweetness to many other varieties."

This is the sum total of our knowledge of this kind which is very probably the same mentioned by Deerr in the article previously quoted as having been introduced into Jamaica by Captain Bligh in 1793, together with his introduction of Otaheite. No cane clearly referable to this variety has been found by us in Porto Rico, though Mr. Deerr informed Mr. Earle verbally of having seen such a cane at some of the loading stations in the western part of the Island at the time of his visit in January, 1920.

White Transparent.

See Cristalina

***Yellow Caledonia. See Plate XXVII, page 305.**

First introduced by D. W. May, Director of the Federal Station at Mayagüez, in December, 1904, from Audubon Park, Louisiana, under the name of Rose Bamboo. Later, in 1909, reintroduced from Ewa Plantation, Hawaii, by Mr. E. E. Olding, then administrator of Central San Cristóbal, Naguabo. First extensively grown and disseminated by Mr. Sewall of Naguabo (see letters of May and Sewall). At present rather extensively planted in nearly all parts of the Island, but especially on the northern and western coasts. Was at one time probably third in total acreage, only exceeded by Rayada and Cris-

talina, but is now rapidly disappearing again, and many centrals refuse to accept it.

Strictly erect, very vigorous, strong stooling, very seldom arrowing. Stalks medium stout, green, with heavy reddish flush where exposed, usually marked with brown lines, bloom none or very faint. Internodes medium length, straight, cylindrical, furrow none. Nodes not constricted; growth ring rather broad, 2 to 4 mm., even or a little sunken, usually light green; root band narrow, somewhat oblique, 6 to 10 mm., greenish; rudimentary roots small, dark purple, in 3 to 4 rows; leaf scar glabrous, nearly perpendicular, narrow, appressed behind; glaucous band conspicuous, about 8 mm., usually reaching but not exceeding the growth ring, margin uniform, very narrow, germination long delayed, subapical, nearly glabrous except for heavy apical tuft which reaches 4 mm. Leaf sheaths glabrous, green or sometimes tinted below, glaucous, conspicuously stained with purple within, especially at base, throat wide, dark brown, densely lannate, a circle of sparse rather short hairs behind the ligule, especially toward the margins and extending unto the shoulders; collar broad, dark brown, extending to the midrib, densely lannate, ligule tapering toward the ends, 2 to 4 mm., margin uneven, somewhat fimbriate; ligular processes none. Leaf blades erect with the tips declined, flat, broad, 7 to 8 cm., dark green, very minutely serrulate, the margin even below or sometimes scantily ciliate.

The extensive planting of this cane led to many heated discussions between mill owners and *colonos*, the former wishing to restrict its planting on account of its low average sucrose while the latter insisted on planting it because of its high tonnage. This trouble largely came because the nature of the variety is not well understood. If cut green at 11 to 12 months, and especially if rains are frequent, it will have very little sucrose and be high in reducing sugars, making the yield so small that it does not pay to grind it. It is a late-maturing cane, requiring age and at least 4 to 6 weeks of dry weather in which to ripen. It should never be cut before April when, though never as rich as Cristalina, it will give a very satisfactory yield. If handled in this way, on old compacted lands, it will give a much larger output of sugar per acre than either Rayada or Cristalina. It is preeminently a low-land cane thriving only moderately on dry hills. It should not be planted on lands that still give a satisfactory tonnage of the better kinds. It is especially indicated for those old and compacted maritime *vega* lands where Rayada and Cristalina now fail from root disease. In such localities it will give much greater ton-

nage and will ratoon for many more cuttings. If allowed to fully ripen the yield or sugar will be highly satisfactory. It would not be possible to run a central at a profit if all of its fields were planted to this cane, since all would mature so late as to make too short a grinding season. It is simply folly to cut this cane green and rush it to the mill before it has developed any sugar.

Yellow Caledonia is very resistant to the ordinary forms of root disease and it is a strong ratooner. As it almost never arrows it can be safely carried over as "long crop" or "*caña quedada*", as is so extensively done with it in Hawaii. In some soils in Porto Rico, however, it tends to become hollow and dry if carried over to the second year. It proves, however, to be rather susceptible to the vascular-bundle fungus, fields having been occasionally seen that were seriously injured from this cause. It is very susceptible to mosaic, or at least it is very seriously injured by it when attacked, the growth being immediately dwarfed and the plant often actually dying within a few months. In some instances it seems to contract the disease less readily than some other kinds. Diseased plants are so easily recognized that roguing is made easy. It is probable that more attention has been paid to cleaning up fields of this kind in order to secure a supply of clean seed than with any other variety. It is very resistant indeed if not fully immune, to gum disease, which at the present moment is a matter of great importance.

The following selected analyses will serve to give an idea of what may be expected of this kind under different conditions of ripeness and immaturity. For a fuller discussion of its chemical qualities and analyses from other parts of the Island see Circular 33, by ex-Director E. D. Colón, now general manager of Central Plazuela, who has made a comprehensive study of this variety under Porto Rican conditions:

Kind	Date	Age	Extr.	Brix.	Sucr.	R. S.	Puri.	Fiber
Y. Cal.	2-1912	Plant	.. .	15.2	11.8	2.6	74.8	.. ....
Y. Cal.	12-8-20	Rat. 10 mo ...	72.4	13 01	8 60	3 16	66 15	9.98
Cristalina.	12-8-20	Rat. 10 mo. ..	78 9	15.63	13.41	1.78	85.76	10,80
Y. Cal.	1-24 21	Rat 15 mo. ..	67 4	16.60	13 37	1.51	80.54	13.44
Cristalina...	1-24-21	Rat 15 mo....	70.3	17 85	16 14	0.83	90.42	11.26
Y. Cal.	2-4-21	Pl. 16 mo.	61 5	18.90	17.70	0 69	93 65	13 86.
Cristalina	2-4-21	Pl 16 mo ...	65.2	18 40	17.27	0 85	93 85	11 23

This last is the only case in our records where Yellow Caledonia has fully equaled Cristalina grown under the same conditions. It was from a dry hill top where the cane was fully mature, but it illustrates the folly of cutting this kinds when it only contains 10 or 12 per cent sucrose.

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APPENDIX A

SIMPLE CHARACTERISTICS WHICH CAN BE EMPLOYED FOR DISTINGUISHING BETWEEN CERTAIN PAIRS OF DECIDEDLY SIMILAR VARIETIES

Ba–6032 & Ba–11569.—In the former the buds exceed the growth ring by ⅓rd of length, while in Ba–11569 they scarcely exceed growth ring.

BH–10(12) & Ba–6032.—Ba–6032 has a pronounced brownish growth ring not usually encountered in the former.

BH–10(12) & B–117.—The latter has a long and wide apical tuft on the bud, whereas the apical tuft in BH–10(12) is very scant or wanting.

D–117 & B–1809.—D–117 has a long and wide ligular process on one side only, whereas in B–1809 the ligular process is wanting or very poorly developed.

PR–328 & 358.—In the latter the buds exceed the growth ring by ⅓ of length, while in PR–328 they barely exceed the growth ring.

PR–433 & 492.—PR–492 has a well developed, broad and long apical tuft on bud, while in the former the apical tuft is decidedly scanty.

Yellow Caledonia and D–625.—The latter has a pronounced bright red growth ring, which is much less conspicuous and usually green in Yellow Caledonia.

APPENDIX B

GLOSSARY: TERMS USED IN DESCRIBING CANES

Acuminate: ending in a long, drawn-out, slender point.
Acute: ending in a sharp point.
Apical: at the apex or point.
Arrow: the flower of the cane, including the panicle and its stalk.
Basal places: the dense mass of short, appressed, usually crisped hairs found at the base of the buds.
Bloom: a coating of wax on the stalks and leaf sheaths.
Ciliate: fringed with long, waxy hairs.
Cm.: centimeter; one hundredth of a meter ($2\frac{1}{2}$ cm. = 1 inch).
Collar: the outside angle at the joining of the leaf blade and leaf sheath.
Concolorous: of the same color.
Dorsal: on the back.
Fimbriate: margin uneven, with minute points; fringed.
Flush: the change in color of a green cane to pink, red or purple when exposed to light.
Furrow: a groove in the internode extending up from the bud.
Glabrate: nearly glabrous, almost smooth.
Glabrous: smooth, no coating of any kind.
Glaucous: covered with a thin, waxy coating, bloom, coated with wax.
Growth ring: a narrow circle where the root band of the node joins the internode above. The tissue of this ring remains long in a condition of active growth. If the stalk fall over, the growth of this tissue enables the top to again become erect.
Habit: the general appearance and mode of growth.
Internode: that part of the stalk between the nodes. The word "joint" is sometimes popularly used for the internode, but again it may mean the node.
Lanceolate: long and pointed but broader below, like the head of a lance.
Lannate: woolly, covered with short, more or less felted hairs.
Leaf blade: the free green part of the leaf.
Leaf scar: the base of the leaf sheath which remains on the stalk when the leaf falls.
Leaf sheath: the base of the leaf which encircles the stalk.
Ligular process: protuberance at the top of the leaf sheath at the throat where the leaf blade joins the sheath.
Ligule: a short, horny membrane pressed against the stalk at the throat where the leaf blade joins the sheath.
Margin (of bud): a flat, sterile fold or the outer bud scales. It may be narrow or broad, uniform in width or shouldered.
Mm.: millimeter; one-tenth of a centimeter or the one-thousandth part of a meter.

Node: That part of the cane where the bud is situated. It includes the growth ring, the root band, the leaf scar, and the glaucous band.
Obovate: egg-shapped; broadest above.
Obtuse: blunt; not sharp pointed.
Orbicular: nearly circular in outline.
Oval: broadest in middle with ends equal and rounded.
Ovate: egg-shaped; broader below.
Peduncle: the stalk of the arrow; the flower stalk.
Plicate: folded like a fan.
Rachis: the central axis of the flower panicle; really a prolongation of the peduncle.
Root band: that region of the node above the bud where the ends of the rudimentary roots may be seen ready to protrude and grow when the cane is planted.
Serrate: with the margin cut into sharp notches like saw teeth.
Serrulate: the margin with very small teeth.
Staggered: zig-zag; internodes not in straight line.
Stooling: the comparative number of stalk in a hill; suckering; tillering.
Throat: the inner angle where the leaf blade joins the sheath.
Triangular-ovate: the base broad and rounded but the sides straight and ending in a point.
Tumid: irregularly swollen or enlarged.
Undulate: wavy.
Vestiture: a coating of hairs.

APPENDIX C

A SELECTED ANNOTATED BIBLIOGRAPHY OF PAPERS DEALING WITH CANE VARIETIES IN PORTO RICO

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(3) Resultados Obtenidos en Demostraciones con Variedades de Caña P. R. Depto. de Agra. y Trabajo, Circ. de Fomento 7, pp. 11–32; San Juan, 1926. Gives results and conclusions from demonstrations with BH–10(12), D–109, Rayada, SC–12/4, Cristalina, PR–410, 412, 440, 460 & 543 and L–511.

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(4) An unsigned editorial in *Revista de Agricultura, Industria y Comercio,* San Juan, 1887, p. 174. Gives an account of Dr Agustín Stahl and his work in introducing cane varieties with a price list of those being propagated by him at Bayamón.

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(6) Cane Varieties at Guánica. Mem. Assn Sug. Technologists of P. R. I, 1, pp. 5–6; June, 1922. Discusses D–117, Rayada, B–3412, Uba, GC–701, D–433, GC–1486, PR–260, BH–10(12) and SC–12/4.

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(10) Morphological Similarity between the Phytium-like Fungus Found Associated with Diseased Sugar-Cane Roots in Hawaii and Porto Rico. Jour. Dept. Agr. P. R., VIII, 2, pp. 61–70; Apr., 1924. Following up Carpenter's important work in Hawaii.

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(11) Making Grand Banks. Mem. Assn. Sugar Technologists of P R., I, 1, pp. 7–8; June, 1922. A practical discussion of this important point in Porto Rican cane planting.

BOX, HAROLD E.
(12) Parasites of Sugar-Cane Moth Borer. Ref. Book Sug. Ind. of World, 1926, pp. 49–52. Discusses these insects in Demerara and Porto Rico.

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(67) Resultados de una Demostración sobre Propagación de Variedades de Caña. P. R. Depto. de Agra. y Trab., Circ. de Fom. 7, pp. 44–6; 1926. Results of a demonstration with PR–417, 440, 460 and D–1135.

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(76) Cane Varieties Resistant to Salt Lands. *Ibid,* pp. 14–15. Description of a very necessary plan for obtaining information on this all-important point in certain sections.

(77) Urge la Extinción del Matizado. Rev. de Agra. de P. R., XIII, 4, pp. 249–50. 1924. Some more dotting of i's and crossing of t's in some plain remarks by the man who first called attention to practical mosaic control in Porto Rico.

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(110) La Caña Java P.O.J. 228 Rev. Tuc., III, pp. 139–42; Sept., 1912. Critical exptl. comparison of P.O.J. 228 with 36, 213 & 234. "P.O.J. 228 was inferior in every way to the other varieties—in chemical analysis as well as in yield of cane."

(111) The Most Promising Varieties of Cane under Trial at the Tucumán Expt. Station. I. S. J., XVI, pp. 12–23; 1914. Contains in English practically the same subject matter as (109).

(112) Las Cañas de Java en la Estación Experimental Agrícola. La Gaceta, Tucumán; May, 1914. Comments on breakage of a mill roll said to have been due to high fiber content of P.O.J. 234 being ground at time. "It is positively ridiculous to take the attitude that these high-fiber canes cannot be successfully ground in the modern Tucumán centrals . . . The high fiber content of some of these canes does not in any sense constitute an obstacle to their employment . . . In a simple mechanical problem such as this is Tucumán ought to be able to find the same solution which has been encountered by any other sugar country." Gives fiber content of P.O.J. 36, 213 & 234 and shows that many Java mills grind continuously canes with higher fiber content than any of these.

ROSENFELD, ARTHUR H.—Continued

(113) Maduración de las Cañas Extranjeras. Rev. Tuc., IV, pp. 527–9; 1914. Analyses made in April, 1914, some two months before initiation of crop (corresponding to October in P. R.), showed good stages of maturity for some of the most promising P.O.J. canes. P.O.J. 234 again demonstrated itself a very early maturer with 86% purity and 14% suc. in juice. P.O.J. 36 showed 80.4% and 13.8%. "The Java 234 & 36 (P.O.J.) seem to possess in high degree the characteristic of early maturity which is so outstanding in our native canes."

(114) Discurso en Reunión de Plantadores, 14 May, 1914, Rev. Tuc., V, pp. 1–4; Jun., 1914. Calls attention to need of caution and patience in variety expts., as well as to positive danger of jumping at conclusions from a few years' results. "This point should be clearly demonstrated by the fact that, almost without exception, the new varieties of cane which gave us the most promising results the first year of their trial are not today, after four years of careful and accurate investigation from every standpoint, . . those we can recommend for replacing the native canes."

(115) Las Cañas de Java y su Contenido de Sacarosa. Rev. Tuc, V, pp 199–207; Oct., 1914. Various comparative analyses of P.O.J. 36, 213, & 234 with native canes in Tucumán during 1914 crop. P.O.J. 234 appears in one analysis from Expt. Sta. with 20% sucrose in juice and in another from San Pablo with 19½%. "The analyses of the Java canes have turned out relatively as good as those of the canes of the country."

(116) Ensayos con Abonos durante Cuatro Años. Rev Tuc., V, 8, pp. 323–61; Jan., 1915 Uniformly negative results from comm fertilizer applications to Rayada cane indicate that Mosaic Disease has so weakened cane that it does not respond to fertilization.

(117) Memoria de la Estación Exptl. Correspondiente al Año 1914. Rev. Tuc., V, pp. 415–37; Mar., 1915. Short review of work of Station with varieties, especially the P.O.J. canes, during year.

(118) Resultados de Cinco Años de Experimentación con Variedades de Caña. Rev. Tuc., VI, 6, pp. 231–78; Nov. 1915. "P.O.J. 36, on account of the characteristics already discussed, appears to be the cane destined to replace the Creole (Rayada) cane in our Province, the P.O.J. 213 & 234 . . . . following in the order of their mention."

(119) Plan del Campo Experimental. Estn. Exptl. Agr. de Tuc., Circ. Especial; 1915–16. Notes on various expts. with P.O.J. canes and diagram of exptl. plats.

ROSENFELD, ARTHUR H.—Continued

(120) Maduración de las Cañas Extranjeras. Rev. Tuc., VI, 434–6; Mar., 1916. Analyses of P.O.J. 36, 213 & 234 made latter part of April, 1916. "The analyses . . . show . . . very respectable percentages of sugar in the juices of these varieties which we now know to be of early maturity and enable us to predict for the coming crop at least normal purities."

(121) Identificación de las Cañas de Java. Rev. Tuc., VI, p. 437; Mar., 1916. Planters who desire to propagate P.O.J. 36, 213 & 234 should be certain that seed they obtain is of these varieties and if in doubt should send specimens to Expt. Sta. for identification.

(122) La Caña Kavangire. La Gaceta, Tucumán; 15 Abril, 1916. Calls attention to confusion amongst certain planters in identification of Kavangire & P.O.J 234. "The planter who purchases Uba thinking that he is obtaining P.O J. 234, paying the price demanded for the latter, is losing money."

(123) La Estación Experimental Agrícola de Tucumán en el Centenario de la Independencia Argentina. Rev. Tuc, VII, pp. 1–82; 1916. "The value of these investigations has been recognized both within and without the country, not the least important of these being those which have enabled the Station to recommend to the planters a series of cane varieties which give far superior results to those commonly employed, as well as the best methods of planting, seed selection, cultivation, etc."

(124) Some Epoch-Making Experiments in the Argentine: The Java Canes in Tucumán. Sugar, N. Y., Dec., 1917. Discussion of results with Java seedlings in Tucumán and their bearing on the Argentine sugar industry.

(125) Some Remarks on the Tucumán Sugar Industry. Published by American Commercial Club, Buenos Aires; Dec., 1918. An address before the Comm. Club, covering more or less same ground as (124)

(126) Estudios Gráficos de las Diversas Variedades de Java en las Colonias de Santa Ana. Rev. Tuc., X, 2, pp. 57–8; 1919. "According to yield and analysis there is little to choose between the 36 and 213, the former probably being preferable only on account of its erect growth, small amount of lodging and easier stripping."

(127) La Estación Experimental de Tucumán; Retrospecto de sus Trabajos. Revista Azucarera, Buenos Aires, XVIII, pp. 305–9; Oct., 1919. "In the present crop 90% of the cane ground in the Province is of the Java varieties."

(128) What the Tucumán Expt. Station has Done for the Argentine Sugar Industry. I. S. J., XXI, pp. 488–93;

Rosenfeld, Arthur H.—Continued.

1919. Covers in English largely the same ground as (127).

(129) Some notes on the Tucumán Sugar Industry. I. S. J., XXI, pp. 605–8; 1919. Brief description of climate and short history of sugar industry in that Province up to the time of the replacement of the commonly grown canes by the P.O.J.

(130) Kavangire—Porto Rico's Mosaic-Resisting Cane. I. S. J., XXII, pp. 26–33; 1910. Considers that thinness of Uba and P.O.J. varieties does not constitute an insuperable objection to their adoption. "The thin, rapid-growing, but not at all aesthetically appearing P.O.J. 36 & 213 . . . have been universally adopted in Tucumán, only a few rows of native cane being seen today, carefully guarded and nursed as an invalid might be by the friends of his youth."

(131) La Caña Kavangire en Tucumán y Puerto Rico. Rev. Azucarera. Buenos Aires, XVIII, pp. 146–8; May, 1920. Contains in Spanish practically same subject-matter as (130).

(132) The Argentine Sugar Industry. I. S. J., XXII, pp. 388–94; July, 1920. Mentions tremendous impulse given Arg. sugar industry by P.O.J. 36 & 213.

(133) Power Cultivation of Sugar Cane. I. S. J., XXII, pp. 499–501; Sept. 1920. Tractor cultivation of P.O.J. 36 & 213, with a number of cuts of methods and machinery employed.

(134) The Question of the Distance between Cane Rows. I. S. J., XXII, pp. 558–65 & 629–35; Oct. & Nov., 1920. A rather detailed study of results obtained in various parts of the world, including those obtained at the Tucumán Expt. Sta. with native canes and with P.O.J. ones later employed as basis of experimentation.

(135) The Java Canes in Tucumán. I. S. J., XXII, pp. 681–3; Dec., 1920. Gives results obtained at Ingenio Santa Ana with P.O.J. 36 & 213 on very large scale, these results covering over a thousand acres.

(136) The Question of the Distance Between Cane Rows. I. S. J., XXIV, pp. 72–6; 1922. Bringing (134) up to date.

(137) Lo que la Estación Exptl. de Tucumán ha Hecho por la Industria Azucarera. La Hacienda, Buffalo, pp. 291–6; Oct., 1922. History of the work of the Tucumán Station with varieties and calculations of money value of the substitution of the native canes in that Province by the P.O.J. varieties recommended by the Station.

(138) La Caña Kavangire. La Hacienda, Buffalo, pp. 131–4 & 169–72; May & Jun., 1923. Stresses point that, just as high fiber content of P.O.J. canes in Tucumán did

Rosenfeld, Arthur H.—Continued

may prevent their universal adoption there, this factor should not weigh too heavily in the balance against the use of Uba cane in Porto Rico.

(139) A Beneficial Aspect of the Sugar-Cane Mosaic Disease. I. S. J., XXVI, pp. 191–5; Apr., 1924. "In the heaviest-infected districts along the west and northwest coast (of P. R.) . . . the tolerant P.O.J. 36, 105 and 213 are being employed on a large scale with most promising results."

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(141) Annl. Repts. of the Special Technologist for Cane, 1923–24 and 1924–25. In corresponding reports of the Insular Experiment Station of Porto Rico. Brief resumés of work under way during the various years.

(142) "Luz y Aire" en el Cultivo Moderno de la Caña. Rev. de Agra. de Puerto Rico, XIII, 4, pp. 237–48; Oct., 1924. A discussion of wide planting of sugar cane the world over, in which the varietal variation of row distance is also considered.

(143) The Java P.O.J. Canes in Tucumán and Porto Rico. Journ. Dept. Agr. of P. R. VIII, 3; July, 1924. A complete study of the behavior of these canes in two widely separated and climatically distinct countries.

(144) Crítica del Sistema Jeswiet. Chaparra Agrícola, I, 9, pp. 34–5; Ene., 1925. A letter to Dr. Eva Mameli de Calvino in regard to the applicability of the Jeswiet system of varietal classification in widely separated parts of the globe.

(145) Present-Day Cane Varieties. In Barrett's "Food Plants of Porto Rico", *Ibid*, IX, 2, pp. 94–8; Apr., 1925. A discussion in brief form of the varieties most popular in Porto Rico at this time.

(146) Tucumán & Louisiana—A Parallel. Ref. Book Sugar Ind. of World, July, 1925.

(147) The BH-10(12) and SC-12/4 Canes. *Ibid*, IX, 3, pp. 215–247; July, 1925. A discussion of these two most promising canes in all the West Indies.

(148) Maximum Conclusions from Minimum Data. La. Planter & Sugar Mfr., Nov. 1925.

(149) La Estación Experimental Agrícola de la Sociedad Nacional Agraria del Perú. Proyecto Presentado a la Sociedad Nacional Agraria; Lima, 1926. A survey of the sugar and cotton industries of Peru by the Special Cane Technologist of the Porto Rican Insular Experiment Station, with recommendations for the establishment of

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(150) Report of the Division of Agronomy. Annl. Rept. Ins. Expt. Sta. of P. R., 1924–25. (Published Sept., 1926).

(151) El Gusano Chupador de la Caña de Azúcar. Rev. Ind. y Agr. de Tucumán, IV, pp. 229–366; 1913–1914. Calls attention to reduced borer infestation in the thinner, more fibrous canes of the P.O.J. type.

ROSENFELD, ARTHUR H, & BARBER, T. C
(152) Trabajos de las Sub-Estaciones 1912–13. *Revista Industrial y Agrícola de Tucumán* (Argentina), IV, pp. 495–514, 1914. Give some of the first substation results with the P.O.J canes, which experiments finally made possible the rapid change-over to these varieties a few years later.

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(152) Informe del Agrónomo Regional. Msto Nacl. de Agricultura de la Rep Argentina, 1917. Rept. on visits to two sugar centrals in the northern Province of Jujuy, where he reports favorably on plantings of P.O.J. canes.

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(154) Estudios Prácticos sobre la Enfermedad de la Caña. *La Prensa,* 5th April & 2nd May, 1878. (Reprinted in La Enfermedad de la Caña, 1880, below).

(155) La Enfermedad de la Caña de Azúcar en Puerto Rico. San Juan, 1880 In this most important paper Dr Stahl brings together all the various reports that had been published regarding the cane epidemic of 1872. He gives 23 kinds of cane known to occur in Porto Rico, with notes on their disease resistance.

TAGGART, W. G.
(156) P.O.J. 234, Windrowed and Cut, Sug. Bull. of the American Sugar Cane League, IV, 13, pp. 1–3; 1st April, 1926. Finds surprisingly little inversion in cut and windrowed cane of this variety, which is quite at variance with the results of all other investigators.

VEVE, RAFAEL A
(157) Our Experience with Cane Varieties Memoirs of the Assn. of Sugar Technologists of Porto Rico, I, 1, pp. 28–31; June, 1922. A most interesting review of varietal work at Central Fajardo by one who has done splendid work there.

Veve, Rafael A.—Continued
(158) Influence of Lime on Cane Cultivation. Ref, Book of the Sugar Ind. of the World, published by the La. Planter and Sugar Mfr., July, 1925, pp. 36–7. A short presentation of the important physical and chemical effects of liming on sugar-cane soils in a section where D–433 has long been the predominant variety.

Wolcott, G. N.
(159) The Influence of the Variety of Sugar-Cane on its Infestation by *Diatraea saccharalis* and the Other Factors Affecting the Abundance of the Moth Borer. Jour. of the P. R. Dept. of Agr. & Labor, VI, 1, pp. 21–31; Jan., 1922. One of the few papers extant on the relation of variety to borer infestation.

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(160) Rare Cases of Mosaic Disease in Highly Resistant Varieties of Sugar Cane. U. S. Dept. Agr., Circ. 392; July, 1926. The paper which destroyed the theory of immunity in the Chinese group of canes, practically all of which Yoder has found with slight mosaic infections.

Zerban, F.
(161) Advertencia Respecto a la Importación de Nuevas Variedades de Caña. Rev. Ind. y Agr. de Tucumán (Argta.), I, 1, pp. 16–7; June, 1910. Mentions early introduction of P.O J canes and calls attention to danger of introducing pests and diseases if importations are not properly inspected by competent authorities.

Zerban, F., & Rosenfeld, Arthur H.
(162) ¿Cómo Puede Mejorarse la Producción y Calidad de la Caña? *Ibid,* I, 3 & 4, pp 1–16; Ago. & Sept., 1910. Discuss early production of seedling canes in Barbados and Java.

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ECOLOGICAL SURVEY OF THE FLORA OF PORTO RICO

by

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ECOLOGICAL SURVEY OF THE FLORA OF PORTO RICO

INTRODUCTION

This survey was made possible by the cooperation of the New York Botanical Garden and the Insular Department of Agriculture of Porto Rico. The authors wish to express their appreciation of the hearty cooperation of Dr. N. L. Britton, Director-in-chief of the New York Botanical Garden; Hon. C. E. Chardón, Commissioner of Agriculture and Labor of Porto Rico; Dr. Jaime Bagué, Assistant Commissioner of Agriculture and Labor of Porto Rico; Mr. F. A. López Domínguez, Director of the Insular Experiment Station of Porto Rico; Mr. Wm. P. Kramer, Chief Forester of Porto Rico. The authors also wish to express their thanks to Mr. Augusto P. Alvarez, Dr. José A. Antongiorgi, Hon. Charles Bahr, Mr. C. Z. Bates, Mr. Jorge Bird, Mr. Edmundo Colón, Mr. Rafael Colorado, Mr. Plácido Feliú, Dr. Arthur Hollick, Miss Clara Livingston, Mr. Mariano Mari, Mr. Juan Masini, Dr. Wm. R. Maxon, Mr. José I. Otero, Dr. B. E. Quick, Mr. Julio César Ramírez, Mr. Virgilio Ramos, Mr. R. A. Toro, Mr. R. A. Veve, Mr. Percy Wilson, and to many others through whose courtesy and assistance the field work was facilitated and made pleasant. The photographs were made by Rafael Colorado of San Juan.

The greater part of the field studies were made between January 16 and April 30, 1926, during which time the authors devoted practically all of their time to the work. The plans for the work were made largely by the senior author previous to the field work and the herbarium studies were made largely by the junior author after the field work was finished.

The results of this survey were first published by the New York Academy of Science in the Scientific Survey of Porto Rico and the Virgin Islands, Vo. VII, Parts 1 and 2 (February 1927). This is a popularized edition of this same work and is less extensive The illustrations, with some few exceptions, are the same in the two publications.

Since the Island of Porto Rico includes some 3,400 or more square miles of territory, it was impossible to study all parts of

it or to make statistical or experimental studies within the short period of four months allotted to us. Therefore, the time was devoted to the making of field studies of selected areas which are believed to be representative. The soil, climatic and other environmental factors have been noted, the dominant and secondary species listed so far as possible, their inter-relations described and the successional trends determined as far as possible from observational studies.

The appearance and structure of any plant association depends largely on the species present and the relative numbers of individuals of each. The species of almost all associations display a variety of forms and the preponderance of the individuals of any one form determines the general character of the vegetation. Most of the plant associations of Porto Rico, like those of other tropics, are composed of many species of the same vegetational form which therefore rank as codominant. Although any group of these species may produce the same ecological results, it is important to determine those which exert the greatest control on the environment, since the most abundant species are those best adapted to the existing physical environment. In the cat-tail sedge (*Typha-Mariscus*) association, in which two species constitute the greater part of the association, the determination of the dominant species is simple. In a mountain association which may be composed of a hundred arborescent species, the selection of the most abundant and most important can not always be accurately made by observation alone. Therefore, it is probable that future studies will show cases where the lists of species given are imperfect.

The discussions of the environmental factors have been based on publications of the United States Weather Bureau, the Reports of the Scientific Survey of Porto Rico and the Virgin Islands, on the geology and physiography of the area and our own observations. Since it has been impossible to make experimental studies, this work is primarily descriptive. The fact that a certain association as described grows under certain environmental conditions does not necessarily mean that the association is determined by those conditions. The primary cause of the association may depend on factors which are operative now or have been operative in the past. In deciding upon what appears to be the trend of succession, we have been guided by the recognized principles of ecology and the processes of physiography; also by the effective activities of vegetation so far as they could be observed in our field studies.

The great changes in the distribution of plant life and the destruction of the original growth over large areas which have resulted from the activities of man over a period of many years has made it impossible for us to do our work with accuracy and completeness. The dense population of Porto Rico has made use of almost all the available land for dwellings and agricultural purposes and the result has been the modification to a greater or less degree of the original plant associations as found in a state of nature.

Realizing the importance of accuracy in the determination of the species under discussion, we collected and preserved many specimens which have been identified; most of the flowering plants by Dr. N. L. Britton and Mr. Percy Wilson, authors of "The Botany of Porto Rico and the Virgin Islands", at the New York Botanical Garden; the grasses by Dr. A. S. Hitchcock of the U. S. Bureau of Plant Industry at Washington, D. C., and the ferns by Dr. Wm. R. Maxon of the National Herbarium at Washington, D. C.

The field work included studies on selected areas (see fig. 1) in all parts of the island. We were greatly aided in this work by the advice of Dr. N. L. Britton and by the personal guidance of Mr. William P. Kramer and Mr. C. Z. Bates.

Although Porto Rico has been visited by many botanists, the ecological studies have been very meager. The establishment of National and Insular Forest Reserves has led to a few valuable descriptive studies; Urban published on the phytogeographical affinities of the flora and also a flora of the Island; many expeditions from the New York Botanical Garden resulted in the publications on the Botany of Porto Rico and the Virgin Islands by Britton and Wilson; the geological surveys published by the New York Academy of Sciences and scattered ecological notes have all proved helpful in our work.

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GEOGRAPHY, PHYSIOGRAPHY AND GEOLOGY

Porto Rico is the smallest of the four islands known as the Greater Antilles and is the most eastern and most southern of that group. It is located between 17° 54′ and 18° 31′ north latitude and 65° 13′ and 67° 15′ west longitude and is well within the American tropics. The four islands, Cuba, Jamaica, Santo Domingo and Porto Rico which constitute the Greater Antilles and that crescent-shaped chain of smaller islands extending from the east of Porto Rico to South America, known as the Lesser Antilles, appear to be the tops of an enormous range of mountains. Many of these peaks show evidence of volcanic action and some few have been active within recent years. However, none of the peaks in Porto Rico shows any evidence of recent activity.

The ocean a short distance north of Porto Rico is approximately 7,500 meters (25,000 ft.) deep, while the Caribbean Sea to the south is approximately 4,500 meters (15,000 ft.) deep. The channels between Porto Rico and the islands on the east and west are 200 meters (600 ft.) deep. As to whether this range of mountains now represented by these islands was once the northern boundary of South America, the northern part of which subsided, thus forming the Caribbean Sea, is a matter of conjecture. However, it is evident that Porto Rico was once lowered until a considerable part was under water and then raised again.

The island is almost rectangular in shape and approximately 182 kilometers (113 miles) long by 66 kilometers (41 miles) wide with an area of about 8,900 square kilometers (3,425 square miles). It is almost rectangular in form and its greatest dimension is east and west. It is divided into north and south parts by an east-and-west mountain crest. This mountain range is crescents shaped and has its eastern terminus in El Yunque, which is about 1,060 meters (3,500 ft.) in height. Starting with El Yunque, this range extends to the southwest and then to the west with an elevation rarely exceeding 150 or 200 meters (500 or 600 ft.), for a considerable distance. It then rises abruptly to about 800 meters (2,500 ft.) between Cayey and Guayama. The range curves slightly to the northwest to the vicinity of Aibonito where the elevation is near 650 meters (2,000 ft.). From this point west the elevation is about 650

meters until we come to the vicinity of Adjuntas where there are several peaks which exceed 1,350 meters (4,000 ft.). Near Adjuntas, it divides into two ranges, the one extending west to Mayagüez, and gradually dropping to the sea level, the other extending northwest to near Rincón and gradually dropping to sea level. Smaller mountain ranges extend in a more or less north-and-south direction and subdivide the island into numerous fertile valleys. The crest of the main east-and-west range is about 10 or 12 miles from the south coast. Therefore, about two-thirds of the island is north of the crest, and about one-third south of it. The highest summits are in the vicinity of Jayuya, near the centre of the isalnd; Cerro de la Punta is the highest point in Porto Rico, reaching an altitude said to be 1,330 meters (4,492 feet). These ranges and elevations are shown on the map (Fig. 1).

That part of the main mountain range east of Aibonito is known as Sierra de Cayey and that part west of this point as the Cordillera Central. There is a third and smaller range which includes El Yunque and is known as Sierra de Luquillo in the eastern part of the Island. In fact, these three ranges may all be considered as part of a single main range The table-lands on this main range are usually narrow, one of the widest of the tables lying between Cayey and Guayama. The north-and south ranges are usually narrow and are known as *cuchillas* or knives. Small water falls, cascades and rapids are frequent, especially on the north side of the main ranges.

Geologically, the greater part of the island is of volcanic ([1]) origin with limestone deposits of a later period around the margins. The volcanic activity during the Cretaceous period covered the land deeply with tuffs, ashes and other volcanic ejecta. Some of this volcanic material fell into the waters of the Caribbean Sea and formed shale which was eventually elevated and formed the shale hills of the southwestern part of the island. During the early part of the Tertiary period, a considerable part of the island was submerged and the area above the water reduced to about two-thirds of its present size. Thick deposits of limestone were laid down during this period and raised above sea level by a later uplift. This elevation was greater along the north than along the south coast. The northern uplift is roughly bounded by a line extending from Loíza through Río Piedras, Corozal, Ciales and San Sebastián to Aguadilla. The uplift of the south side consists of a narrow strip. These

[1] More extensive studies of the geology will be found in the various reports of the N Y Academy of Science on the Scientific Survey of Porto Rico and the Virgin Islands.

extensive movements have been followed by other subsidences and elevations of less importance

It will be readily seen that the central part of the island is composed largely of igneous materials, which on the north and south sides are covered by a coastal plain, formed during one or more periods of submergence The long period of erosion has given rise to the peneplane and has cut many deep V-shaped valleys The erosion has brought down great quantities of silt which has been deposited near the mouth of the rivers and has aided in the formation of the flat coastal plains and playas Although the valleys of the island are the results of long periods of erosion, there is a surprisingly little wash or erosion at the present time The steep slopes, many of them under intensive cultivation, wash so little as to attract the attention of the visitor Berkey attributes this stability of the soil to three factors

"One is the clinging character of some of the vegetation which tends to bind the soil together, another is the small range of temperature variations which reduces disintegration or disruptive tendencies to a minimum, and still another is the low content of inert or refractory materials, such as quartz, in the rocks whose destruction has furnished the soils, all of these factors favor the making of special tenacious soil"

It will be readily seen that the coastal plain of the north side of the island is more extensive than that of the south coast It extends the entire length of the north coast and at Lares extends inland to a distance of about 10 miles and to an elevation of about 1,200 feet It is primarily a limestone shaly formation laid down during a period of subsidence and overlaps the igneous formations A considerable part of it is characterized by the limestone hills which are called "mogotes", "pepinos" and "hay stacks" and by the sink holes of various sizes The north coastal plain is in general more rugged than the south coast, due to the wind and wave action in forming a series of sand-dune zones. West of Quebradillas the coast line is formed by very abrupt limestone cliffs with an occasional trace of the San Juan sand-dune formation The old consolicitated dunes can be traced along the entire north coast of the Island except for the extreme eastern part, but are not continuous. The most prominent dune forms the point or promontory on which El Morro stands From San Juan westward, it can be traced easily, sometimes forming a coast line and sometimes forming rocks or small islands near the shore. It is especially prominent from

near Barceloneta to near Arecibo, forming a pronounced ridge which separates the Caño Tiburones from the sea. The Arecibo lighthouse is on the extreme western end of this ridge. In most places the sea appears to be wearing this line of sand dunes away, but in some places there is evidence of rebuilding due to the action of the wind and the binding power of the vegetation.

West of Arecibo the sand dunes of the San Juan formation are very prominent but are pretty generally covered with fresh sands which gives the appearance of new dunes. The action of the vegetation in holding these new deposits of sand in place is very evident. West of Camuy, these consolidated dunes are much less prominent. Two isolated developments of this formation are found at Cape Rojo at the extreme southwest corner of the island.

Just south of the sand-dune formation we find rather narrow recent marine or fluvial deposits. The sand dunes are most prominent east of Arecibo, gradually disappearing west of that city. South of this, in the part east of Arecibo, we find the Arecibo limestone formation which is dissected into mogotes, pepinos or hay stack hills. This limestone is very white and weathers into numerous holes. Decaying vegetation collects in these holes, decomposes into soil and supports a dense thicket of vegetation. Sink holes are numerous in this region but not so conspicuous as in the western part of the island. Going west from Arecibo the Quebradillas limestone becomes more and more prominent and is characterized by conspicuous sink holes, lost rivers and caves. West of Quebradillas the coast line is characterized by high cliffs, extending to Aguadilla. The west coast of the island is characterized by alternating high limestone cliff formations and low playas lying at the mouths of the rivers. The south coast line west of Ponce is very similar to that of the west end of the island. Between Ponce and Guayama lies a very distinct coastal plain, averaging about four miles in width and never more than 300 feet in elevation. In many places the coast line resembles the coast line along the eastern end of the island, but coral reefs are more highly developed than at other places. There are also large deposits of silts and extensive growths of mangroves. The coastal plain includes extensive areas of salt marsh lands, some of which have never responded to cultivation. East of Guayama, high cliffs are prominent except where interrupted by the valleys. Many of these valleys are broad and fertile and used extensively for agricultural purposes, especially cane growing. The mouths of many of the streams of this region are choked with

sand bars which in some cases have given rise to rather extensive swamp areas.

There are several small lakes in the coastal region, but none in the elevated part of the island. Back of the consolidated sand dunes between Barceloneta and Arecibo is the "Caño Tiburones", a brackish marshy region which has been partly reclaimed and planted to sugar cane. It is connected with the sea at the lighthouse just east of Arecibo. "Laguna Tortuguero," near the coast of Vega Baja and Manatí, is a very similar formation, but does not have any connection with the sea. There are other low areas of smaller size in this region which may represent swamp or lake regions of the past. Some of the small, low areas just back of the sand dunes and west of Arecibo are in reality small canales. West of Quebradillas there is to be found the formation of sand bars at the mouths of the rivers which if undisturbed may result in the future development of conditions very similar to the "Caño Tiburones."

There are 40 or 50 streams which are designated as rivers and several hundred small streams. The longest rivers are on the north side of the island. During dry periods they may appear to be of little importance but heavy rains in the mountains change them to dangerous torrents in a very short time. They are not navigable but are valuable as sources of water supply and for power. Most of the rivers on the south coast are dry for the greater part of the year, but occasionally become dangerous torrents as the result of rains in the mountains. These rivers are formed by the union of the small streams which are present in the numerous valleys. There are said to be nearly 1,500 of these small streams. It will be readily seen that the conditions are especially favorable for the rapid run off of the water resulting from the very heavy rainfall. However, in the limestone regions, sink holes and underground drainage are very prominent. The islands of Vieques and Culebra are geologically the same as the eastern part of Porto Rico.

GENERAL PRINCIPLES OF THE DEVELOPMENT AND STRUCTURE OF VEGETATION, AS APPLIED TO PORTO RICO

A. Development of the Flora of Porto Rico

Volcanic rocks of the Cretaceous age are the oldest formations contributing to the surface of the island at this time. The rich flora of seed plants over the face of the earth during the Cretaceous period is shown by the fossils found here and in other parts of the world. There is no reason to believe that the volcanic activities were

continuous or that they prevented the migration of plants to Porto Rico or the formation of forests. There have probably been some minor volcanic activities and various changes in level since the close of the Cretaceous period but no evidence that the entire Island has been submerged or that the phanerogamic vegetation has not been continuous. There appears to be but two sources of the Island flora; migration from other regions and evolution within the Island.

The immigration of plants to Porto Rico is independent of the present relation of the island to other islands of the West Indies. If Porto Rico at some time in the past was physically connected with the other islands, plants would naturally have migrated overland. If the island has been separated from other lands from its earliest geological history, plant migration would have been retarded but not prevented. However, the entrance of plants into Porto Rico appears to have been continuous from the Cretaceous period to the present and the future will see many additions to our Island flora.

The most rapid immigration of plants into Porto Rico began with the coming of man. The Caribs are known to have traveled from island to island and no doubt carried many plants with them. The coming of the Europeans marks the beginning of a new period of plant immigration which resulted in the introduction of our most important agricultural plants and many weeds. Many of the weeds have never spread beyond the limit of human influence and are to be found on farms, roadsides and waste places. The same agencies that brought plants to Porto Rico have also taken plants from Porto Rico to other parts of the world, especially to the neighboring islands.

Botanists are still ignorant as to the details of the time and place of the origin of the great majority of the known species of plants. Fossils from the Cretaceous and Tertiary periods show great similarities in families and genera but the species are very generally distinct. The evidence indicates that as a result of the evolutionary agencies, the majority of the early species have become extinct and have been replaced by species of recent origin. Although the evidence is not so clear in Porto Rico as in other parts of the world, there is no reason to believe that the Porto Rican flora has been any exception.

From the many possibilities of migration and evolution, it is evident that the species of Porto Rican plants may be divided into a number of categories as follows:[1]

[1] From Plant Ecology of Porto Rico.

A. Species common to Porto Rico and other parts of the world:
   1. Originating elsewhere by evolution and reaching Porto Rico by immigration.
   2. Originating in Porto Rico by evolution and reaching other lands by immigration.
   3. Originating both in Porto Rico and in other lands by evolution from common ancestral stock.

B. Species endemic to Porto Rico:
   4. Originating elsewhere by evolution, reaching Porto Rico by immigration, and becoming extinct in the original habitats.
   5. Originating in Porto Rico and not at present colonized in other lands by immigration.

Our present knowledge of the geological history of the West Indies and their floras is not sufficient to enable us to assign many plants to their places in this scheme but future studies of the morphological character, geographical distribution, and ecological behavior of the species will add much to our knowledge of the history of the vegetation of Porto Rico.

B. Plant Migration

Each species, whether established in Porto Rico by evolution or by immigration from some other part of the world, has the entire area of the island available for future migration and colonization. The ability of a species to migrate depends on the structure of the organs or parts by which it migrates and their ability to utilize the various agencies for their movement. The capacity of a species to migrate is very generally underestimated. Some species, especially agricultural plants and weeds, are carried by commerce. They may travel very rapidly over very large areas and are frequently accompanied by other species of plants of little or no value to man. Heavy fruits come to rest within a short distance of a parent plant and travel very slowly. The majority of species lie between these two extremes. *Vernonia cinerea* (L) Less. is a good example of the first; its seeds are produced within few months and are easily carried by the wind. The jácana (*Lucuma multiflora* A. DC.) is a good example of the second; its large fruits fall to the ground and require many years to produce a second generation. Therefore, we would expect the former to migrate more rapidly than the latter, but the jácana may possibly be carried by some agency to distant points and give origin to new foci of distribution. It is well known that seeds are frequently carried for long distances by storms, by water, by birds, by mammals and by other agencies. If the fruit

of the jácana comes to rest not more than 20 meters from the plants and it requires 10 years to grow and produce a second generation of fruits, it will require 80,000 years for the species to extend its range the length of Porto Rico, but accidental distribution of its seeds to a greater distance by fruit-eating birds or mammals will bring about the same result in a much shorter period of time

It is evident that some species may have been introduced into Porto Rico many times and in many places, and that species arising by evolution may have appeared in groups and over considerable range. In either case the time required for occupying the area would be very short as compared to starting with a single individual. It is also reasonable to suppose that some species may have come into Porto Rico or been evolved so recently that they have not had time to extend their ranges to the limit.

Evolution and immigration have probably been continuous from the Tertiary and possibly from an earlier period to the present and it is possible that they have been fully as active at one time as another. This means evolution and immigration over a million years or more. Since a species may complete its migration in a few centuries, it appears that most of our plants have had sufficient time for their complete migration over the Island. However, our field studies show that many native species of the Luquillo Mountains are not known elsewhere; the rocky summit of "El Yunque" has at least three endemic species. This is not due to the lack of migration but the failure of the seeds to establish themselves in new sites or to natural barriers between suitable sites. The former is more important in Porto Rico that the latter.

Each species requires a more or less definite combination of conditions for the germination of its seeds and growth of the plants. These conditions involve soil, soil water, atmospheric moisture, temperature, light, air movements and very often association with certain other organisms. If the variations of any one or more of these factors exceed the tolerance of the plants, the seeds fail to germinate or the young plants fail to reach maturity. Therefore, each combination of environmental characters makes possible the growth of certain species and excludes others.

The differences in the flora of two widely separated localities with apparently similar environments may be due to obscure environmental differences or to the failure of species to migrate over or through natural barriers. It is not always possible to determine this from field observations. This is illustrated by the flora of "El Yun-

que" and "Cerro de la Punta". These peaks appear to have similar environmental conditions although the latter has less wind, less rainfall and a drier and possibly a slightly cooler atmosphere. The vegetation is similar but two of the four characteristic species of shrubs and low trees on the summit of "El Yunque," have not been found on "Cerro de la Punta". The environmental differences do not appear to be sufficient to exclude the two species from "Cerro de la Punta," but between these two peaks there is a gap of about 70 kilometers in which conditions are not suitable for the growth of these two species. Therefore, it is not possible at the present time for them to migrate slowly across the intervening country from one point to another. It may be that the conditions never have been favorable for them to migrate from one point to another but it is possible that they may at some future time appear on "Cerro de la Punta." There are many other cases in Porto Rico, but definite explanations are impossible with our present incomplete knowledge.

However, there are many cases in the island in which the nature of the inhibitory factors is very evident. Common ferns of the genus Dicranopteris are characteristic of the mountainous regions of the central parts of the island. Their spores are readily carried by the winds and new plants start promptly in new and favorable locations. Their normal habitat is on the rocks and cliffs of the forests, but they immediately invade the newly made banks of the roads. There can be no doubt that the spores are carried by the wind every year to the limestone hills north of the mountain range, yet the plants do not grow in these locations, and it is very probable that this is due to unfavorable soil conditions.

The llume palm (*Gaussia attenuata* (Cook) Beccari) is characteristic of the limestone hills or *mogotes* of the north side of the island. The tall, slender trees of this species are scattered over the summits of many of these hills and young plants may be found on the hills throughout this region. A few individuals of this species are also present on the limestone hills of the southwestern part of the island which indicates that it has the ability to migrate. Its absence from many of the limestone hills or mogotes appear to be due to the difficulties of migration rather than to environmental differences.

It will be readily seen that the origin of the flora of any habitat is very complicated as is well illustrated by the flora of these limestone hills or mogotes. A mogote is usually occupied by about 200 species of flowering plants, more or less, and the great mass of the

seeds of these plants do not migrate to any great extent, although there is, no doubt, more or less migration between the hills every year. The result is that the hills are now occupied by floras which are essentially the same. The *Dicranopteris* ferns and other species undoubtedly migrate to these hills to a greater or less degree but do not become established because of the unfavorable environments.

C. The Environment

In the preceding pages we have emphasized the fact that in most cases the presence or absence of a species cannot be determined by a single environmental factor, but that a number of factors are usually involved, some of which are favorable and some unfavorable for the species. A plant rarely, possibly never, grows where all the factors are most favorable for its growth but under a combination of factors some of which may be unfavorable for its optimum growth. A great number of environmental combinations exist in Porto Rico. They consist of variations in rainfall, ranges of temperature, velocity of wind, character of soils, intensity of light and many other factors. Erosion, base leveling and rock decomposition are changing the habitats of the plants; destroying or changing old habitats and making new ones.

To the physical and inorganic changes must be added the changes brought about by growing plants themselves, which are working continuously and gradually changing the physical and chemical nature of the soil, producing humus, and modifying the wind, light and atmospheric humidity. In the older parts of the Island where the physiographic and vegetational processes have been active for many thousands of years, each change of the environment has been followed by corresponding changes in the plant life, which have in turn resulted in other changes of the environment. The environment in some of these places has come to a state of relative stability and the plant life will probably remain very nearly stable for many years to come. The environment in other places is changing rapidly and each change is followed by a corresponding change in the plant life which becomes a part of a new environment and which may tend to retard or accelerate future changes. In still other but rather limited areas, new sites for plant life are forming and starting on what may be long cycles of change or may be destroyed after relatively short periods of existence.

Each of these many habitats in Porto Rico has certain environmental factors which the vegetation cannot materially change.

These factors are temperature regulated by broad climatic conditions; rainfall regulated by same broad climatic and physical agencies; wind regulated by the location and topography. However, the stable factors are a small part of the environment which is otherwise subject to great modification by the plant life. The larger plants intercept and reduce the light which is so necessary for their own seedlings and for many smaller species. They also modify the wind currents and increase the atmospheric moisture and thus reduce transpiration. They modify the soil both physically and chemically by their roots and by the accumulation of decaying material. It will be readily seen that plants not only modify the environment but become a part of it. However, the influence of plants is extremely variable, ranging from a minimum on the sand dunes and along the coast generally to a maximum in the mountain forests, but is ever present and every acre of land in Porto Rico demonstrates these interactions through long periods of time which in some cases may extend back to the Cretaceous period.

The physical and vegetational features of the environment are so important in the development of the present plant life of the island, that the destruction of its original vegetation by man is usually followed by new associations of plant life. Abandoned fields that were formerly in forest are soon covered with a dense growth of ferns. The removal of the natural growth around the *mogotes* is followed by an abundance of the various species of *Piper*. The flooded mangrove swamp are an exception to this rule in that they regenerate themselves very soon after cutting. The explanation of all this cannot be definitely given until we have more exact information which we trust will come with future studies. However, we believe the inferences which we have made in many cases are justified by our observations.

In the following description of the plant life of Porto Rico, the leading features of the environments are given for each type of vegetation, but we will discuss the broader features of temperature and rainfall in this place.

Porto Rico is well within the tropical zone, is surrounded by water and almost constantly under the influence of the trade winds, which are mostly from the east and northeast, and which tend to reduce the fluctuations in temperature. In this connection it should be remembered that there are four kinds of temperature variations: (1) a daily variation with a minimum shortly before sun rise and a maximum shortly after noon; (2) a variation from day to day

in which warm and cool days may alternate; (3) a seasonal variation depending on length of day and altitude of suns; (4) a variation from year to year. In Porto Rico, the range of temperature during a single day is very seldom more than 20°F. at the coast and 30°F. in the mountains. The variations in mean temperature from day to day is seldom more than 5°F. The difference between the warmest and the coolest month of the year is from 5° to 8°F. The variation from year to year is not more than 1°F. The average annual temperature for the coastal plains over a period of twenty-four years is 78°F. and for elevations of 2,000 to 3,000 feet is 72°F. The extremes of temperature during this same period were a minimum of 41°F. in the higher elevations and a maximum of 94°F. in the coastal regions. These variations in temperature are so slight that it is doubtful if they have any influence on the distribution of plant life. (Fig. 2.)

The altitudinal variation in temperature is accompanied by changes in the plant life. Many species of the coastal region do not ascend much above sea level. Good examples of this are the bucar (*Bucida buceras* L.) which is quite common on the south coast and the cóbana (*Stahlia monosperma* (Tul.) Urban) of the east and west ends of the island. The sierra palms (*Euterpe globosa* Gaertn.) appear in the Luquillo Mountain at about 600 meters (2,000 ft.) and in the Central Cordillera at about 900 meters (3,000 ft.), extending to the highest points. However, the variations in temperature from lowest to highest points is so gradual and the boundaries between the *sierra* palms and ridge forests so abrupt that temperature cannot be considered the sole factor in fixing their distribution. In general, it may be said that a species of plant can grow and reproduce in extremes of temperature to which it is not subject in its natural range, and therefore, that there are factors other than temperature, which tend to fix the range. (Fig. 2.)

The atmosphere of these regions is ladened with moisture practically all the time. The moisture-laden winds sweeping in from the east and northeast, are checked by the mountains, and the hot air from below forces them up until they come in contact with the cooler strata of air above. The cool air causes a precipitation of moisture and heavy rainfall. Dense clouds form with very great rapidity and heavy rains follow at any time during the greater part of the year. These rainfalls are local, sometimes covering small and sometimes large areas, but are far more abundant on the north than on the south side of the mountain range. The most frequent and the heaviest rainfalls are in the highest mountains. (Fig. 3.)

The effect of the heavy rainfall is to be seen on both soil and vegetation. The deep valleys and gorges with their very steep sides are the results of the heavy rainfall and and runoff. The soil is very cohesive and does not erode, even on the cultivated hillside, as rapidly as one would suppose. (See page 8). This makes agriculture possible on the slopes of 30 to 40 degrees. The lack of rainfall is equally evident on the south side of the principal mountain range.

When we realize that an annual rainfall of 80 inches or more is generally necessary for the formation of a true rain forest in the tropics and that an annual rainfall of 40 inches will usually fail to support a vegetation more luxuriant than desert scrub, it will be readily understood that the amount of annual rainfall is of the greatest importance in determining the character of the plant life and its distribution in Porto Rico.

The mesophytic vegetation is dominant on the north side of the principal mountain range and for a short distance south of it, where the change to xerophytic scrub is remarkably abrupt, a distance of one to three kilometers frequently resulting in a very marked change in the general character of the plant life. The rainfall, the atmospheric humidity and possibly some other factors are responsible for this sudden and most remarkable change in the plant life. The rela' onship of temperature and humidity to altitude is well known. As the air currents rise and pass over the mountains from north to south, they become cooler and a part of thei' moisture is precipitated as rain; as they descend on the south side they become warm and relatively dry, which affects the transpiration of the plant life of that region. This condition and the reduced rainfall favor the development of a xerophytic vegetation. Unfortunately there are no records to show the comparative evaporation of water from free surfaces on the two sides of the mountain range.

The xerophytic types of plant life may also be favored on the south side by the frequent and long droughts. The observation station at Potala reports 88 periods of drouth of more than ten days each, and with an average of 21 days during the nine years from 1914 to 1922. Some of these periods were 80 days in length and in the best year for plant growth there was a drouth of 28 days. It is very evident that a normal mesophytic vegetation cannot develop under these conditions unless there is an unusual amount of soil water to compensate for the low rainfall. We cannot assume that this complexity of environment always favors directly the growth of certain species at high altitudes. It may act indirectly by preventing the

growth of certain species and thus leave more available space for the growth of those species that can grow under the existing conditions. But if some factors such as the lowering of the temperature is unfavorable for, or eliminates certain species, then the remaining species will produce a large number of individuals This is illustrated by the sierra palm zone of the Luquillo Mountains, which are located on the northeast corner of the Island where there are high winds and rainfall as compared with the corresponding zone in the Central Cordillera The xerophytic nature of the vegetation of the southern coast of the Island has already been mentioned and it appears that the temperature is a contributing factor in this region The daily temperatures are higher than on the north coasts and the plants are exposed daily to a greater isolation and drier atmosphere and to a higher temperature

In summarization we may say that the important climatic features of Porto Rico, such as rainfall, atmospheric humidity, wind and temperature have a distinct relation to the topography, that they exert an influence on the distribution and grouping of species in distinct associations, but that no one of them alone enables us to make a satisfactory explanation as to the nature of the distribution of plant life in Porto Rico The relative importance of these various factors in the distribution of plant life cannot be determined except by careful experimentation

D THE PLANT ASSOCIATIONS

Plant ecology may be broadly defined as a study of the relation between the plant and its environment, and the term environment as including every factor that influences the plant when growing in its natural surroundings These environmental factors are reflected in the many variations in the structure and behavior of the plant, excluding those features inherited from proceeding generations These environmental effects are here grouped under three general heads as follows:

(1) The environmental influences control the structure and behavior of the plant to some extent The shape of the leaf of a plant is inherited but the size, thickness, amount of chlorophyll, number of stomata and structure of the vascular bundles may vary with the amount of light and water. All plants of a particular environment do not necessarily present the same structural characters as a result of the environment, but many species do show the same structural characteristics, which gives the vegetation a more or less uniform appearance.

(2) No species of plant can grow in all, or even a majority of the available types of environment and each species has a certain range of environment within which it can grow and reproduce Therefore, the areas in which a more or less definite environmental complex is repeated, tend to be occupied by the same species Furthermore, the plants of any particular area tend to modify the environment for themselves and for the other species, so that there arises an interrelationship between the species The result is a very definite grouping of plants which resembles the social and political organizations of man These groups are known as plant associations The field of plant ecology includes the study of these plant associations, their characteristics, their mode of development, their relationship to the environment and their relationship to each other in both time and space

(3) The various environments affect and control the distribution of all species on the face of the earth All the individuals of any species require essentially the same environments and the species is restricted to the part or parts of the world where these environments exist However, the species does not necessarily exist in all parts of the world where the environments are favorable The study of the distribution of a species and of the environmental agencies which led to its distribution is known as plant geography or phytogeography Ecological studies show that many species of plants do not occupy all the available parts of the earth Some species are restricted by impassable barriers and other are still migrating

An ecological survey deals with the various plant associations of a region, the species of which each is composed, their characteristics and general appearance, their relationships to the environments and their relationships to each other in time and space It does not include a study of the structure and behavior of the individual plants, or the geographical distribution or classification of the larger groups.

There are few phenomena of plant life more evident than the fact that the vegetation of a region is not uniform and that gradual variations from one type of vegetation to another are unusual The vegetation of a region is usually divided into associations, each occupying a small or large area and very uniform in general appearance. These associations may be repeated but the transition from one type to another type is usually abrupt and often readily distinguished by an untrained observer This is well illustrated by the swamp vegetation of the north coast of Porto Rico, where there are hundreds of acres covered with pure growths of mangle. On the

land side of these mangle growths are found equally pure but smaller growths of a bracken fern or cat-tails, but they do not mingle with the mangle growths. Neither do the ferns and cat-tails mingle.

The formation and maintenance of these associations depend on migration and environment. Many seeds and spores of many species of plants must necessarily be carried into each of these pure associations every year but they do not grow. If a new swamp should be formed, the seeds and spores of many species would be carried into it and nature would select those suited to the environment. However, it should be remembered that the plants themselves will modify the environment. They shade the ground, reduce the light and thus prevent the growth of species which require a maximum of light. The leaves and twigs decay and increase the available humus and this modifies the amount of available soil water. Thus the environment is gradually changed by the plants themselves.

The general appearance of any plant association depends on the number of species represented, their size, color, form and other characters. Some of these species which are similar in size and appearance may out-bulk the others and determine the general appearance of the whole association. This is well illustrated in the mangrove swamps which include three species, very much alike in size and general appearance. Beneath the larger plants will usually be found many smaller plants which could be removed without changing the general appearance of the association. Of course the species with the most numerous and largest individuals will exert the greatest influence on the environment. They are dominant species.

In Porto Rico such environmental factors as temperature, light and rainfall vary gradually from place to place and the same is usually true of the soils; but the changes in plant life are usually very abrupt. Therefore, it will be readily seen that it is not always possible to explain the transition in vegetation on a physical basis alone. It appear that they must be explained to some extent by the influence of vegetation on the physical environment. That is, the gradual variation of the environment may become abrupt as a result of the different reactions of two unlike sets of species. This is well illustrated by the brackish waters of a Porto Rican lagoon in which there is no abrupt variation between the fresh and the salt waters but in which the circulation is restricted by the density of the vegetation and other environmental factors. There we find a

sharp line between the mangroves and bracken fern of the saline waters and the cat-tails of fresh waters near the shore.

The environments of plant life are always changing. The lakes, ponds and swamps are usually becoming shallower as a result of the soil being carried into them by streams following the heavy rains and by deposits of muck formed by the vegetation. The soil of the hills and mountains is being washed away by rain and the underlying formations of soil and rock exposed. In every case, the change of environment makes possible greater or less changes in the plant life. Some plants die as a result of the change and new species are introduced by migration. Therefore, any plant association can have but a limited duration in any one place. Eventually the original species disappear and their places are taken by new ones which are better suited to the new environments. This change of vegetation is known as succession.

It is very evident that the lifetime of any plant association is dependent on the rapidity of the changes of the environment. This is well illustrated by the coastal and mountain plant associations of Porto Rico. The sand dunes of the north coast are continually changing and each change is followed by new associations, which in time are again destroyed and replaced by others. In the mountain regions the environments are more stable and the changes in plant associations so slow that the associations are almost permanent. It is not likely that any great natural changes will occur in these regions unless there should be some great geological activities such as uplifts or depressions. It is useless to speculate on the past or future of such associations.

In conclusion we must repeat that plant associations are the basic units of plant life; that they are the results of immigration and environmental selections and that the length of their duration depends on the rate of environmental changes. It is the purpose of an ecological survey to record and described these associations, to correlate them with the environments, to interpret so far as possible their past histories and to predict so far as possible from the existing evidence their future history.

The survey of the plant life in Porto Rico indicates the presence of a large number of different plant associations. Some of these occupy large areas and were probably continuous before they were partly destroyed by man. Some cover small areas and are scattered and frequently isolated. Some have had a precarious existence because of the changes in their environments. Some do not show evi-

dence of any changes except those brought about by man Some are the results of the activities of man in cutting, burning, clearing and agriculture The past history of the associations of short duration can be traced with reasonable degree of accuracy, and their futures may be predicted with some degree of certainty. The study of the history of associations of long duration is much more difficult.

The many plant associations of the limited areas of Porto Rico make some system of classification necessary We have, therefore, designated three primary groups which are geographical and based on the broad features of soils and climates They are as follows. (1) The plant life of the northern coastal regions which are of limestone or alluvial soil and have heavy rainfall (2) The plant life of the central mountain regions in which the soils are mostly volcanic and over which the rainfall is heavy. (3) The plant life of the south coastal region in which the soils are diverse and the rainfall low

In the central mountain regions there are five major plant associations and practically no evidence of successional relationships In the two coastal regions there are many associations which we have grouped according to their successional relationship The Island also shows many secondary associations in which the changes are due to the activities of man In some cases the larger plants have been cut for fuel and nature permitted to proceed in her own manner In others the original vegetation has been removed for the promotion of agriculture and the native vegetation now restricted largely to waste areas and roadsides These have been omitted from these studies

An ecological survey of Porto Rico is necessarily very incomplete because of the extensive development of agriculture and the density of rural population Some associations were found in the natural or semi-natural state in but a single locality, similar habitats which might have supported the same or similar plant life being under cultivation These cases led us to believe that the original vegetation was uniform, and therefore we have described these individual stations as typical of the original condition In other cases we can only refer to the natural vegetation as extinct

NOTE For the convenience of those readers who may not be familiar with ecological terms we insert the following definitions

Hydrophytes are plants which grow in water or saturated soil *Xerophytes* are plants which grow under more or less arid conditions. They frequently exhibit structures adapted to the conservation of their water supply. Plants living in sea water, or in soil impregnated with salts, frequently have a xerophytic aspect and are known as *halophytes*. *Mesophytes* are plants which live under

average conditions of water supply, and include the great majority of the species of Puerto Rico.

A *successional series* is a sequence of plant associations, following each other in time on the same area of ground. The successional series may be *mesarch*, *xerarch*, *hydrarch* or *halarch*, depending on the mesophytic, xerophytic, hydrophytic, or halophytic nature of the first association in the series.

VEGETATION OF THE NORTHERN COASTAL PLAIN

A. General

That part of Porto Rico lying north of an irregular line drawn through Loíza, Río Piedras, Corozal, Ciales, Lares and Aguadilla was submerged during the Tertiary period and covered by a thick deposite of limestone. Since that time it has been alternately elevated above the sea and submerged. Each elevation above the sea must have been followed by the establishment of plant life and each submergence by its destruction. The character of this old plant life and its distribution are subjects for future investigations. Each elevation above sea level must have been followed by erosion and soil formation and these same agencies are in operation today: sometimes hastened, and sometimes retarded by the presence of plant life.

The highest point of the coastal plain at the present time is about 400 meters (1,300 feet) above sea level and is no doubt the oldest part of this formation. The plant life of this highest part probably completed its development as a mesophytic forest long ago, but its destruction by man makes it impossible to do more than approximate its nature. This forest reached a temporary climax and a mesarch series of successions may be traced to the climax forests of the low lands.

The elevation of this area has varied during post-Tertiary times but the general tendency has been towards emergence, and new land along the coast has been made available for the plant growth. The vegetation of these new coast lands is hydrophytic at the margins of the lagoons and along the streams; halophytic in salt marshes and mangrove swamps; and xerophytic along the sandy beaches and on the sand dunes. Three succesional series which are correlated with the above may be traced; hydrarch, halarch or xerarch; all culminating in the climax forest of the lowland. (Fig. 4.) This climax forest has been removed and the land used for agriculture; most of the intermediate series have also been changed by the influence of man; therefore, it is impossible to study the complete series. Furthermore, the periods of subsidence were probably accompanied by a reversion of the usual successional series but we

have no method of determining whether the intermediate stages have been the same for both elevation and submergence The recent demands of a dense population for fuel, building materials and land for agricultural purposes have resulted in many changes in the vegetation and in many secondary successions

B THE MESARCH SUCCESSIONAL SERIES OF THE LIMESTONE HILLS

The limestone strata of the north coastal plain may be divided into five geological series, the Quebradillas and Cibao series which show little erosion except the rolling surfaces and the steep sided ravines with streams at the bottoms and the Arecibo, Los Puertos and Lares series which show extraordinary amounts of erosion, which have resulted in a characteristic hill formation known as pepinos mogotes, or haystacks The area of the Quebradillas and Cibao series has been very generally utilized for agriculture

The mogotes of the Arecibo Los Puertos and Lares series are more or less rounded or elliptic in outline (Fig 5) with steep sometimes precipitous slopes and sharp or ridge like summits They may be in close contact or separated by small valleys which are drained through sink holes Hundreds of these mogotes varying from 15 to 100 meters in height are the most prominent features of the land scape between San Juan and Arecibo Older belts of mogotes are prominent between Arecibo and Lares The limestone of which these mogotes are composed is eroded into sharp points and edges and into deep crevices and pockets (Fig 6) which hold the accumulations of decaying plants and develops into a rich soil The soil is thin, but deep crevices hold enough to give a footing for plants and the result is a dense vegetation which sometimes includes large trees that have escaped the ax The soil in the valleys between these mogotes is deep and rich and is extensively used for agriculture The soil in the middle of these valleys has been leached by the heavy rains for so long and accumulations of decaying plants have been so great that it is usually acid, while the newer soils at the bases of these mogotes, which have been recently formed from limestone, are usually alkaline Pineapples growing in the alkaline soils generally show chlorosis Sugar cane, citrus fruits, tobacco and vegetables are also grown in these soils

Both surface and subterranean erosion are still active Rain water may be carried away by surface streams or may flow into the many crevices and pits which are constantly enlarging and being filled with soil There are many caves, some of them of considerable

size throughout this region. Fallen blocks of limestone at the bases of the mogotes show that the processes of disintegration are still active. Many of the intervening valleys are not drained by surface streams but through sink-holes. Most of these are filled with soil but some of them are open, deep, of large size and subterranean streams my be heard at the bottom. Open sink-holes and lost rivers are most common near the western end of the north coastal plain. Although the rainfall of the western part of the north coastal plain is less than that of the eastern part, it is sufficient to support a mesophytic forest and it is probable that the plant life of recent time was of that type.

The San Juan formation is a narrow strip of the low limestone hills extending, with occassional breaks, from a short distance east of San Juan to a short distance west of Camuy. It is composed of calcareous sand held together by an organic cement derived from decaying vegetable matter. This has been developed from a series of fixed dunes in comparatively recent times. It is seldom more than one kilometer in width, or more than 50 meters in height. The old fortress of El Morro at San Juan and the lighthouse at Arecibo are on the highest points. This formation is much less prominent east of Arecibo than west of that city. The subterranean erosion in this formation is unimportant but the surface weathering as a result of the activities of the water is very evident and apparently rapid, although Indian carvings in some of these caves must be more than 400 years old. The original sharp outline of the major part has been softened with time and covered with a layer of soil which supports a limited agriculture, but the few remaining thickets resemble those of the limestone mogotes a short distance inland so closely that it is reasonable to suppose that the original plant life of the two was essentially the same.

1. THE MESOPHYTIC FOREST

The original mesophytic forest of both the limestone mogotes and the San Juan formation has been destroyed or greatly modified. It is impossible to approximate its ecological character from the few remaining mature trees, as they are species of no economic value, such as: almácigo (*Elaphrium simaruba* (L.) Rose), cupey (*Clusia rosea* Jacq.), jagüeys (*Ficus laevigata* Vahl and *F. Stahlii* Warb.), and the llume palm (*Gaussia attenuata* (Cook) Beccari) which is so characteristic of this part of the Island. It is probable that the entire coastal plain of the north was covered with a very uniform forest before the coming of the white men.

Murphy, in his discussion of the forests of Porto Rico (26), also refers to the destruction of this original type of forest, and states that moralón (*Coccolobis grandifolia* Jacq.), aceitillo (*Simaruba tulae* Urban), capá amarillo (*Petitia domingensis* Jacq.), bay-rum tree or malagueta (*Amomis caryophyllata* (Jacq.) Krug. & Urban) and the granadillo (*Buchenavia capitata* (Vahl.) Eichl.) are reported to have been very common on the limestone hills, together with other species of large trees.

This forest was the last of the successional series which started soon after the elevation of the north coastal plain above the sea. It passed through unkown stages in its development and probably existed as a temporary climax for thousands of years, keeping pace in growth and changes with the erosion of the land surface.

2 THE SECOND GROWTH THICKETS

The rapid increase in population and the utilization of the most available land for agriculture has resulted in the destruction or modification of the mesophytic forests and a secondary succession of the present thicket associations on the Arecibo, Los Puertos and Lares upland limestone. All this has resulted in a modification of the environment, increasing the amount of light available for the development of the ground flora, increasing the wind exposure which is accompanied by increased transpiration, increasing the removal of soil by surface erosion, decreasing the accumulation of vegetable mold, decreasing the amount of soid water and increasing surface evaporación. Although these changes in environment have probably not yet caused the extermination of many species, they have certainly led to considerable change in the numerical proportions of a large number of individual. Species which prefer shade and a moist air have decreased in abundance, while those which prefer sunlight have increased. Numerous additional species, mostly weeds, have been quick to immigrate into the region. Nor are the changes in environment and vegetation as yet complete. A continually increasing population makes greater demands on the thickets for fuel, gradually reducing their density; and the foraging of goats will dobtless help towards the complete extinction of many species and their replacement by grass or weeds. The vegetation of the hills nearer to town already shows the effect of excessive cutting and grazing.

At the present time, the hills appear from a distance to be forested, but upon closer examination, this cover is found to be a dense thicket of shrubs, among which are found large individual trees of worthless species. The tall, slender llume palm (*Gaussia attenuata*

(Cook) Beccari) is endemic and characteristic of these hills and a few individuals are also to be found on the limestone hills of the southwestern coast. The trunks are so slender that they are almost or quite invisible from a distance and the crowns of five or six leaves each appear to float in the air like huge birds. The much-branched and crooked trunks of the almácigo (*Elaphrium simaruba* (L.) Rose) are common and very conspicuous during their leafless period. The llagrumo (*Cecropia peltata* L.) with its coarse ungainly stems and large leaves with the white undersurfaces is also conspicuous and characteristic. The jagueys (*Ficus Stahlii* Warb. and *F. laevigata* Vahl) with their dense leafy crowns and the cupey (*Clusia rosea* Jacq.) with its dark green foliage stand in contrast to the preceding but attract less attention unless seen on the profile of the hills.

At the present time, practically all the land in the valleys between these limestone hills is under cultivation or in pasture but at the bases of the hills there are narrow zones composed of many weedy species intermixed with large herbaceous plants, shrubs and small tress. The most abundant shrubs are higuillos or Pipers, the most common being the higuillo (*Piper aduncum* L.). Other more or less conspicuous species are camasey (*Miconia laevigata* (L.) DC.), rabo de ratón (*Duggena hirsuta* (Jacq.) Britton), Santa María (*Osmia odorata* (L.) Sch. Bip.), with the large herbaceous basquiña (*Pothomorphe peltata* (L.) Miq.) and *Critonia portoricensis* (Urban) B. & W. The most common weedy herbs are the lengua de vaca (*Elephantopus mollis* HBK.), and Margarita silvestre (*Bidens pilosa* L.)

Above this lowest zone is a dense thicket (Fig. 6) of shrubs and small trees, usually from 3 to 5 meters in height which extends to the top of the hill. This thicket includes a large number of species but so scattered that no group appears to be predominant. Our observation led us to believe that the most abundant species are garrocho (*Quararibaea turbinata* (Sw.) Poir.), higuillo (*Piper amalago* L.), laurel roseta (*Nectandra patens* (Sw.) Griseb.) the hueso (*Picramnia pentandra* Sw.), cenizo or espinosa (*Zanthoxylum martinicense* (Lam.) DC.), hoja menuda (*Eugenia procera* (Sw.) Poir.), caracolillo (*Trichilia pallida* Sw.) and the shrubs *Psychotria pubescens* Sw. and *Acalypha portoricensis* Muell. Arg. The most conspicuous of these is the cenizo or espinosa which has very prominent, stout, conical thorns on the trunk. The cupey trees (*Clusia rosea* Jacq.) may start directly in the soil or many grow epiphytically on the rocks and trees for a long time, sending out long aerial roots

which may cling to its support or swing free in the wind. They are frequently suspended from the face of the cliffs and resemble long vines. The supporting trees are frequently destroyed, leaving the cupey standing as an independent tree. The Palo de María (*Calophylum antillanum* Britton) with its smooth glossy leaves of unusual venation the jácana (*Manilkara nitidia* (Sessé & Moc.) Dubard, the malagueta (*Amomis caryophyllata* (Jacq.) Krug & Urban), and the guayabacoa or sebucan (*Rheedia acuminata* (Spreng.) Tr. & Pl.) are very conspicuous. The shruby azota caballo (*Malpighia coccigera* L.) and the encinillo (*Drypetes ilicifolia* Krug & Urban) have peculiar holly-like leaves with spiny teeth. Another characteristic shrub of this and other parts of the island is the poisonous guao (*Comocladia glabra* (Schult Spreng.) which also has spiny leaves. The guano (*Ochroma pyramidale* (Cav.) Urban) is a tree with peculiary lobed leaves, and the shrub *Curcas hernandifolius* (Vent.) Britton with its lobed leaves are also very characteristic. One of the most prominent is the muñeco, (*Dendropanax arboreum* (L.) Dcne. & Pl.), a tree with very conspicuous, crowded, compound leaves composed of broad leaflets. The spiny trunks of palma de coger (*Bactris acanthophylla* Mart.) and espinosa (*Anthacanthus spinosus* (Jacq.) Nees), are conspicuous but not abundant. The gesneriad (*Pentarhaphia albiflora* Dcne.) is a wide-branching shrub of one of two meters growing very commonly in the crevices of the cliffs.

The entire thicket contains a tangle of vines. Some of the most prominent are the true zarza (*Acacia riparia* HBK.) which is very stout and thorny, pringa-mosa (*Tragia volubilis* L.), in which both stems and leaves are armed with stinging hairs, liana uñada (*Bactocydia Unguis* (L.) Mart.), bejuco de sopla (*Elsota virgata* (Sw.) Kuntze), dungey (*Smilax coriacea* Spreng.); bejuco de mona (*Cissampelos Pareira* L.), bejuco de costilla (*Serjania polyphylla* (L.) Raldk.), bejuco de prieto (*Hippocratea volubilis* L.), bejuco de toro (*Stigmaphyllon tomentosum* (Desf.) Ndz.) and *Exogonium repandum* (Jacq.) Choisy. The vine-like grass *Lasiacis sorghoidea* (Desv.) H. & C. is also abundant.

The epiphytes were probably abundant in the primitive forests but are comparatively few at the present time and are usually found on the exposed ledges of rock. One of the most striking in the flor de culebra (*Anthurium acaule* (Jacq.) Schott) which has bright green leaves a meter or more in length which grow in large rosettes. The calabazón (*Philodendron Krebsii* Schott.) climbs the trees and droops over the cliffs. The thick succulent climbing stems of gun-

gulén (*Vanilla Eggersii* Rolfe) with their thick green leaves are also quite common. The erizo (*Pitcairnia angustifolia* (Sw.) Redoute) occurs in masses on the rocky ledges and several other species of bromeliads in sterile condition were observed, most commonly on the jagüey and cupey trees.

The herbaceous plants are decidedly subordinate both in number of species and in number of individuals in each species. The largest is the bijao or narciso (*Alpinia aromatica* Aubl.), which reaches a height of more than two meters. The plants of *Zamia latifoliolata* Preneloup are more common although not abundant. They are very widely distributed and frequently become abundant in new clearings. The shade-loving grases carruzo (*Ichnanthus pallens* (Sw.) Munro) and prenda de oro (*Pharus glaber* HBK.) are common but do not form dense growth. The yerba maravilla (*Ruellia coccinea* (L.) Vahl) is made conspicuous by its scarlet flowers. Madre selva (*Pilea microphylla* (L.) Liebm, yerba de culebra (*Pilea nummulariaefolia* Sw.) Wedd.), yerba de medio real (*Peperomia rotundifolia* (L.) HBK. and *P. magnoliaefolia* (Jacq.) A. Dietr.) are more or less common on the shaded cliffs. There are two common ferns and a number of other species that are met with less frequently. The most common are *Polypodium phyllitidis* L. and *Adiantum cristatum* L.

This type of vegetation is practically the same over the scattered hills and limestone bluffs of the Quebradillas formation. There is less variation from hill to hill than from the north to the south slope of the same hill. The limestone strata dip about five degrees to the north and this slight inclination probably helps to maintain a better supply of moisture on the north side, which also has a somewhat less direct exposure to the sun during the greater part of the year. The north side of a hill usually supports a denser growth of shrubs, bromeliades, aroids and ferns. The leaf mold is deeper and the general appearance mesophytic. The shrub growth of the south side is more open and contains more of a tangle of grasses (*Lasiacis*) and the true zarza (*Acacia riparia* HBK.) which are semi-xerophytic. The north side of the exposed cliffs will be covered with a dense mass of vegetation while those of the south may be almost barren. A continuation of human interference will result in a greater reduction of the plant life to weedy species not relished by goats or other domestic animals.

3. THE RED CLAY-LOAM PLAINS

Along the north side of the belt of limestone hills, are many valleys of varying areas and great undulating plains. The soil is a

red clay loam. These lands are very generally under cultivation, mostly to citrus fruits and pineapples, although there is a considerable acreage of cane, some tobacco, vegetables and a few bananas. In some areas the pineapples grow well but in others they are more or less chlorotic, especially near the bases of the hills. It is well known that the lime in the soil causes a chlorotic condition of pineapples unless there is an abundance of humus. Chemical tests of this soil show that the character of the pineapples is a good index as to the condition of the soil. In general the soil of these valleys is acid except at the bases of the hills where it is alkaline. It is probably a mixture of disintegrated limestone and volcanic soil brought down from points farther south with the decaying vegetation. The leaching of the lime from the surface layer and the accumulation of decaying plants very quickly produce an acid condition.

4 THE FORESTS OF THE LOWLAND WHITE SANDS

Areas of white sands between the limestone hills and the ocean are frequent along the north coast. They are supposed to be the result of disintegration of the hills and are designated as the Arecibo sands. They are most extensive between Manatí and Dorado but are found as far east as San Juan. They are very generally cultivated, the most important crop being sugar cane. The only extensive development of natural vegetation was found on the estate of Miss Livingston, west of Dorado. Our description was prepared from a study of plant life of this estate (Fig. 7).

The land occupied by this forest is flat, level and very little above sea level and has few small depressions and streams. A slight elevation on the sea shore, formed by wind-borne sands is covered with a beach thicket. The soil is composed of white, calcareous sands of unknown depth. The surface is covered with a thin layer of humus, fallen twigs and leaves, which gives a brownish stain to the underlying sands for a distance of two or three decimeters. The surface is thoroughly shaded and very moist. The upper layer of soil is filled with feeding roots. The trade winds do not penetrate the forest more than 50 meters and the conditions are especially favorable for a mesophytic forest.

The dominant trees are only about 20 meters in height; the lumbermen having left a very few veterans. There has been no complete removal of forest and therefore trees of all ages from the few veterans to seedlings of less than one year are to be found. There are few shrubs and still fewer herbs. There are two species of trees of special

interest because of their size and abundance; the mamey (*Mammea americana* L. and the Santa María (*Calophylum antillanum* Britton) both of which reach heights of 20 meters (60 ft.) and have trunks of approximately one meter in diameter. There are numerous small trees and seedlings forming about one-half the ground flora. Muñeco (*Dendropanax arboreum* (L.) Dcne. & Pl.), is ever present but its slender trunks rarely exceed 10 meters in height. Cupey (*Clusia rosea* Jacq.) is conspicuous because of its semi-epiphytic habit, the presence of its long, stout, aerial roots and the color of its leaves. Almácigo (*Elaphrium Simaruba* (L.) Rose) is abundant, malagueta (*Amomis caryophyllata* (Jacq.) Krug & Urban) is common and attains a height of 20 meters. The royal palm or palma real (*Roystonea borinqueña* Cook) is very generally found in the low wet places. Small trees of pomarosa (*Jambos Jambos* (L.) Millsp.) are very abundant along the trails, frequently forming thickets. Other species of trees sufficiently prominent to be mentioned are the aquilón (*Laugeria resinosa* Vahl), the cenizo (*Zanthoxylum martinicense* (Lam.) DC.), sapote de costa (*Manilkara duplicata* (Sessé & Moc.) Dubard), guayabota (*Diospyros ebenaster* (Retz.), higuerillo (*Enallagma latifolia* (Mill.) Small), the corozo palm (*acrocomia aculeata* (Jacq.) Lodd.), the shrubby yaita (*Gymnanthes lucida* (Sw.) and av. pillo or laurel (*Nectandra coriacea* (Sw.) Griseb.).

Seedlings of large trees are quite numerous but the frequent cutting prevents the development of a forest. The most abundant shrub is the bejuco de berraco (*Chiococca alba* (L.) Hitch.) and the second in abundance is *Piper citrifolium* Lam. Other more or less prominent shrubs and small trees are rasca-garganta (*Parathesis serrulata* (Sw.) Mez), hoja menuda (*Eugenia monticola* (Sw.) Urban), cafeillo (*Casearia guianensis* (Aubl.) Urban), palo moro (*Psychotria undata* Jacq.), higuillo de limón and (*Piper Amalago* L.). The vines and viney shrubs are few in number but the most prominent are: the thorny escambrón (*Pisonia aculeata* L.), bejuco de garrote (*Rourea surinamensis* Miq.), gungulén (*Vanilla Eggersii* Rolfe), uña de gato (*Bactocydia Unguis* (L.) Mart.) dunguey (*Smilax coriacea* Spreng.) and bejuco de toro (*Stigmaphyllon tomentosum* (Desv.) Ndz.). Epiphytes are few and consist mostly of sterile Bromeliads; the small orchids *Ionopsis satyroides* (Sw.) Rchb., *Beadlea cranichoides* (Griseb.) Small, and *Liparis elata* Lindl; the ferns, *Polypodium phyllitidis* L., *P. lycopodioides*. L. and *Nephrolepis exaltata* (L.) Schott. are rare. The two low grasses *Pharus glaber* HBK. and *Ichnanthus pallens* (Sw.) Munro are quite common.

The slight depressions previously mentioned contain a thin layer of wet muck, resulting form the decay of the plants, but the only changes in the forest are due to an increased number of royal palms (*Roystonea borinqueña* Cook) and thickets of pomarosa (*Jambos Jambos* (L.) Millsp). Some few of these depressions contain a little muddy water and support growths of eneas or cat-tails (*Typha angustifolia* L.).

There are no evidences of physiographic changes in progress at this time, with possible exception of the small depressions, which might result in further changes in the plant life. There is no certainty that this is the true climax association of the region, because the continued leaching of the lime and increase in humus might result in another succession, with the following vegetation possibly the same as the extinct forest which at one time occupied the alluvial plains of the region.

5 SECOND GROWTH THICKETS OF THE WHITE SANDS

The removal of the forest from practically all of the white-sand plains has resulted in a shrub thicket over that area. Special attention was given to this type of thicket as found along the south shore of the Laguna Tortuguero. The surface of this region is level, frequently broken by shallow ravines which are occupied by intermittent streams during the rainy reasons. The soil is a pure white sand with a relatively small amount of humus. The result is a low water-holding capacity, high surface evaporation and a rapid runoff of surface water; all of which tend to produce a xerophytic environment which has its effect on the plant life.

The thickets are not continuous but alternate with open places. They are most highly developed in the ravines, are from 3 to 5 meters in height and almost impenetrable. The high, open places are mostly barren but support a limited growth of the low shrubs and herbs. (Fig. 8.)

Of the trees and shrubs in this formation, the most common is the icaco (*Chysobalanus Icaco* L.). It is a bushy plant, one to two meters in height, or sometimes higher or with the lower branches resting on or near the ground; under favorable conditions, plants of various ages grow close together. The second in abundance is the tree, maricao (*Byrsonima spicata* (Cav.) DC.), which is tall, erect and rather slender. The next in importance is rama menuda (*Myrcia splendens* (Sw.) DC.), which is a bushy shrub or small tree with a glossy dark foliage. Other shrubs and small trees of these thickets are tintillo

(*Randia mitis* L.), Santa María (*Calophyllum antillanum* Britton), camasey (*Miconia racemosa* (Aub.) DC. and *M. prasina* (Sw.) DC.), maray maray (*Ecastophyllum Ecastophyllum* (L.) Britton), cafeíllo cimarrón (*Casearia sylvestris* Sw.), cerezo (*Myrica cerifera* L.), canela (*Acrodiclidium salicifolium* (Sw.) Griseb.), hoja menuda (*Myrcia citrifolia* Aubl.) Urban, and *Taonabo pedunculare* (DC.) Britton, all of which at this time have about the same height and bushy form. The llagrumo (*Didymopanax Morototoni* (Aubl.) Dcne. & Pl.) is not abundant but is conspicuous because of its large leaves with bronzed lower surface. The occasional thickets of corozo palm (*Acrocomia aculeata* (Jacq.) Lodd.) are quite prominent.

The vines are neither abundant nor distinctive. The most noticeable are the dunguey (*Smilax coriacea* Spreng.), bejuco de sopla (*Elsota virgata* (Sw.) Kuntze), bejuco de mona (*Cissampelos Pareira* L.), and *Cissus erosa* L. C. Rich. There are no epiphytes. There are practically no herbaceous plants under the upland thickets but in the moister places at the bottom of the ravines are found scattered individuals of altea (*Nepsera aquatica* (Aubl.) Naud.), grasilla (*Setiscapella subulata* (L.) Barnh. and *Xyris Elliottii* Chapm.

In the flat open places there is a characteristic shrubby and herbaceous vegetation consisting of a sparse growth of arayuillo (*Ascyrum hypericoides* L.), hediondilla (*Chamaecrista diphylla* (L.) Greene), matraca (*Crotalaria retusa* L.), *Mitracarpus portoricensis* Urban, *Portulaca pilosa* L. and *Cladonia rangiferina* L.

This region has undoubtedly been cut over many times for fuel and the resulting change in environment probably accounts for the presence of so many species not found in the Livingston forest (page 32). This change in environment has been so great that many of the original species have given way to others better suited to the new conditions. Of these new arrivals, the icaco (*Chrysobalanus Icaco* L.) has the advantage because of its proximity, adaptation and efficiency of its edible fruit for migration. Therefore, it has become the dominant shrub. The history of these thickets will probably end in the near future through the utilization of the land for agriculture. If undisturbed by man, the accumulation of humus followed by the better conservation of soil moisture might result in the re-establishment of a normal forest association.

6. REVERSIONARY SUCCESSIONS ON THE SAN JUAN FORMATION

The changes in elevation of the northern coast line within recent time have exposed the San Juan consolidated sand dunes to the

direct action of the sea The result is a rapid erosion and modification of the second growth thicket coverings which are passing through a reversionary successional series in which the plants will eventually be destroyed Although these successions are logically a part of the mesarch series, they also indicate a possible stage in the history of the xerarch series as the plant life associated with them is so closely akin to that of the coastal sand dunes in its environment, dynamics and specific composition Therefore, we will discuss their organization under the xerarch series

SUMMARY

The north coastal plain was originally covered with a limestone deposit and the higher parts were covered by man and replaced by the thickets now found on the limestone hills However much of this limestone strata has been reduced by erosion to a base level which is covered with white calcareous sands which also supported a normal mesophytic forest that has been almost entirely destroyed by man Part of this plain is under cultivation and part has been subject to repeated cutting for fuel The forest association was followed by a thicket association of a different specific composition

C The Xerarch Series of the Sand Beaches and Sand Dunes

Subseries 1—Beaches and Beach Thickets

The conditions for the development of sand dunes is most ideal along the north coast and south along the eastern end of the Island as far as Fajardo Playa, a region which has a free exposure to the trade winds except in the sheltered coves to the west of the headlands of the San Juan formation, where the force of the trade winds is greatly reduced, and on the northeastern part of the Island, where an adequate supply of sand seems to be unavailable Under these conditions the sandy beaches rise gradually to a height of one or two meters above sea level and then pass into flat, sandy plains, or they come into immediate contact with the volcanic hills of the Cretaceous age In both cases we find three zones of vegetation (1) a beach association composed of scattered herbaceous species, (2) an association of shrubs forming a semi xerophytic shrub association, and (3) an almost unknown association, probably of forest which was beyond the influence of the sea and which has been destroyed so that the land might be used for agriculture it is probable that the sandy maritime plains were originally covered with a forest similar to that of the white sand plain, and that the

older hills were covered with a different type of forest of a different genetic history, which was in geographic contact with but not related to the thickets.

1. THE BEACH VEGETATION

The narrow strip of exposed beach, lying between the water and the edge of the thicket is usually from 5 to 10 meters in width and is partly covered by herbaceous species, which are destroyed at irregular intervals by the excessive wave action. Therefore the flora consists of species that can be very quickly re-established from seeds or vegetative parts or from plants that trail down from the higher thickets. The most prominent are the two vines, bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.) and mato de la playa (*Canavali maritima* (Aubl.) Thou.), the shrubby *Chamaesyce buxifolia* (Lam.) Small, the true herbs mostacilla de mar (*Cakile lanceolata* Willd.) O. E. Schulz), and botón blanco *Borreria verticillata* (L.) Meyer, the grass matojo de playa (*Sporobolus virginicus* (L.) Kunth) and the three sedges *Fimbristylis spathacea* Roth, *Kyllinga peruviana* Lam. and *Remirea maritima* Aubl. It will be readily seen that the plants are engaged in a continuous struggle for the possession of the land in which it is impossible to gain a permanent hold. The plants are destroyed by every storm and new ones develop in a short time. The number of individuals of each species and their location depends primarily on the dispersal and germination of seeds and vegetative parts.

2. THE BEACH THICKETS

The lower margin of the beach thicket marks the upper limit of the ordinary storm-wave action. The most conspicuous species is the shrubby uva de playa (*Coccolobis uvifera* (L.) Jacq.) which is usually most abundant, ranging from low shrubs to small sized trees, depending on exposure or protection from the wind. The icaco (*Chrysobalanus Icaco* L.) is second in importance and usually farther back from the shore and more protected from the wind. The associated species are the shrubs borborón (*Scaevola Plumieri* (L.) Vahl), cariaquillo de Santa María (*Lantana involucrata* L.), tintillo (*Randia mitis* L.) añil (*Indigofera suffruticosa* Mill.), the vine mato azul (*Guilandina crista* (L.) Small, and the herbs matraca (*Crotalaria retusa* L.) zarzabacoa enana (*Stylosanthes hamata* (L.) Taubert) and margarita (*Bidens pilosa* L.)

An excellent example of the wide beach thicket was studied at kilometer 36 east of Mameyes. At the lower margin the number of

species is few and individuals usually not more than one meter in height; but in passing to the higher levels both the number of species and the heights of the individuals increase, some of them attaining as much as 5 meters. The thickets also become dense and almost impassible.

The jayajabico (*Erithalis fruticosa* L.) is the most abundant shrub but other common and characteristic shrubs and small trees are the wattle (*Eugenia axillaris* (Sw.) Willd.), the cachimba (*Rauwolfia tetraphylla* L.), the bálsamo (*Citharexylum fruticosum* L.), the azúcares (*Jacquinia Barbasco* (Loefl.) Mez), *Ernodea littoralis* Sw., palo moro (*Psychotria undata* Jacq.). One of the most striking plants of this formation is the alelí (*Plumiera alba* L.) with its slender branches projecting above the surrounding vegetation. The whole thicket is interlaced by a tangled mass of vines such as mato azul (*Guilandina crista* (L.) Small), the dunguey (*Smilax coriacea* Spreng.), the bejuco de costilla (*Serjania polyphylla* (L.) Radlk.) and the pega palo (*Distictis lactiflora* Vahl) DC.). The development of this thicket is accompanied by the gradual disappearance of the pioneer shrub and small tree growths of *Coccolobis*, *Chysobalanus* and *Scaevola* to which we have previously referred. At a distance of 50 meters from the ocean we meet with a tree growth consisting largely of roble blanco (*Tabebuia pallida* Miers), almácigo (*Elaphrium simaruba* (L.) Rose) and tortugo amarillo (*Sideroxylon foetidissimum* Jacq.), which indicates a completion of the transition from a beach to a forest environment. The land back of the thickets has been utilized for pasture but the few remaining trees indicate that the area was originally occupied by a mesophytic forest, which we believe was similar to that of the forest on the white sands near Dorado (see page 32).

At Dorado, the narrow beach is bordered by a very narrow zone of beach thickets in which the uva de mar (*Coccolobis uvifera* (L.) Jacq.) is the dominant species. The narrow zone is in close contact with the mesophytic forest but several thicket species, such as cachimba *Rauwolfia tetraphylla* L.) and jayajabico (*Erithalis fruticosa* L.), are prominent near the shore. At Mameyes the presence of young trees of roble blanco (*Tabebuia pallida* Miers) near the thickets may indicate an attempt of the forest to establish itself closer to the shore.

The sand of the thickets appears to be stabilized as far as the front margin, and the variations in heights of the individual plants appear to be due almost entirely to the action of the wind. Each

shrub is slightly taller than those in front of it and nearer the shore which results in a gradual slope from one meter to the height of a mature forest. Young trees occupying advanced positions under the shelter of the thickets cause a steeper pitch and if undisturbed the thicket zone would become narrower and narrower until it would occupy a very narrow strip between mesophytic forest and shore as at Dorado. The removal of the forest at Mameyes, followed by the repeated cutting of the young trees of the thicket for fuel has resulted in a comparatively wide thicket zone with a gradual pitch on the surface.

It appears that the beach thickets are very similar to the dune thickets so far as their component species are concerned, but lead to different successional results. At Fajardo Playa the thickets are intermediate in composition between the beach thickets just described and those of the mangrove swamps. They occupy a habitat intermediate in environment between that of the sand beaches and the coastal swamps, and will be discussed later (see pages 56, 63.

Subseries B.—The Sand Dune Vegetation

There are two entirely different types of sand dunes in Porto Rico, dependent primarily on their ages. The younger series, of recent development, consist of loose calcareous sands. They are typical sand-dune formations and move freely under the influence of the wind unless held in check by a covering of plants The older series consists of sand which has been consolidated by an organic cement into a limestone rock, commonly known as the San Juan formation. This formation is continuous for the greater part of the distance from San Juan to Arecibo, the two highest points being the San Juan promotory on which the El Morro fortifications are located and the promontory on which the Arecibo lighthouse is located. In some places this formation stands as a wall protecting the land form the encroachments of the sea; in other places the sea has broken through. Small islands of this same formation which have resisted the action of the sea indicate that the formation was much more extensive in the past and that the shore line was farther out. In some cases the waves have worn caves in this formation and Indian carvings which must be 400 years or more old indicate that the disintegration is rather slow.

The San Juan formation consists of two or possible three parallel series. The farthest inland is the older and averages about one kilometer in width and about 20 to 50 meters in elevation above the sea.

The contours are rounded and flattened by erosión and deposits in the valleys. The youngest or coast series is narrower, lower, steeper and the summits shaped as might be expected in a comparatively recent formation. This series is in contact with the sea at many points and shows the effects of wave action. At some points the sea has broken through (Fig. 9) and occupies areas between the old and the newer series and at some points the outer or newer formation has been completely destroyed.

The active dunes are composed of sands which have washed ashore and been carried inland by the wind. This sand was probably derived from the disintegration of the old San Juan formation. When the old and new series are intact, they are separated by narrow valleys of fertile soil which are very generally used for agriculture.

The history of these dunes may be summarized as follows:

(1) At some time in the past the general level of the land was lower than at present and the sea extended inland as far as the region now occupied by the inner series of consolidated dunes. Large dunes were then formed and consolidated into the present inner series of the San Juan formation.

(2) An elevation of the land caused the sea to recede to the north and permited the formation of a new but smaller series of dunes which in turn were consolidated into our present outer series of the San Juan formation.

(3) This was followed by a subsidence of the land which brought the sea into contact with the outer or new series and resulted in its partial destruction which is now in progress. The sands resulting from this destruction are now being used in the formation of the active dunes.

It is impossible to predict with any degree of certainty the future changes in this region. A future subsidence will result in the complete destruction of the outer dunes and allow the sea to attack the inner series. If the present level is maintained, the present active dunes will become consolidated. If the land is elevated, the outer series will be preserved, the active dunes will become consolidated and a new series of active dunes will be formed.

The active dunes are of very little agricultural value except for the growth of coconuts which is rather uncertain under these conditions. On the other hand, the dunes frequently encroach on and destroy agricultural lands. Many small homes with their small plantings of yautía, sweet potatoes and tobacco are located on the lee

side of these active dunes where they are protected from the wind and the sea Small plantings on the crests of these dunes are invariably protected by wind breaks constructed of palm leaves or other materials The inner series are very generally under cultivation, cane being grown on the richer soils while the poorer are used for grazing and minor crops The valley lands between the inner and outer series are very generally planted to cane unless they are so low as to permit the entrance of the brackish water, when they support good growths of coconut palms

The history of the sand dunes whether active or old is very closely connected with the plant life upon them and nearly all stages can be observed at the present time As soon as an active dune becomes quiet, the plant life attempts to cover it, moving from the land side to the sea, until it comes into direct contact with the destructive force of the wind and wave The result is a further stabilization of the sand which is soon covered by a growth of thicket shrubs This tends to a further stabilization of the sand and the formation of a forest association Any change, such as a subsidence of the land which enables the sea to attack and destroy or partly destroy this formation results in a reversion of this series and the forests give way to thickets which finally disappear leaving a more or less barren shore line which disintegrates under the action of the wind and waves

The mechanics of a dune formation may be briefly summarized as follows The wind tends to carry the loose dry grains of sand and to cause a general leveling of the surface, but any obstruction which tends to reduce the velocity of the wind, also reduces its carrying power and causes it to drop its load of sand behind the obstruction The result is the formation of a dune limited in height by the height of the obstruction and the force of the wind If the obstruction be a plant which can withstand these forces of nature live and grow, the dune will rise gradually so long as the force of the wind is strong enough to carry sand to its top

However, the development of the sand dune is usually more complicated than we have indicated The increase in height is necessarily accompanied by an increase in breadth and plants are necessary for the protection of its slopes But the establishment of plants is not easy and sometimes the dunes are destroyed by the wind and wave before they are completed As the dune increases in height, the force of the wind at its summit is also increased and sand is blown over the top and falls on the lee side Plants vary greatly in their

ability to live under these adverse conditions and the dunes vary in size with the character of the plants which are continually trying to cover them. The dunes of the north coast of Porto Rico seldom exceed fifteen meters in height. The small dunes tend to unite and form long ridges, parallel to the shore. Any break in the plant life of such a ridge dune, either by nature or by man, permits the wind to attack the structure and start disintegration. If this break is not closed, more and more of the vegetation will be destroyed, and a gap formed through which quantities of sand will be carried to start a new dune on the lee side of the old one.

Sand dunes vary greatly in general appearance, in size, in topography and in the plant life which covers them. The beach may be broad or narrow, the dunes large or small, isolated or united, the sand motion variable and the plant life of different species. Sometimes the plant life appears to have the advantage in this continuous warfare with the winds and waves, covers the dunes and extends to the limits of wave action. Sometimes the wind and wave appear to have the advantage and the plants may give way or maintain themselves with difficulty. Sometimes the wind and the waves undetermine large trees and cause them to fall, and at other times the wind carries the sand in such quantities as to bury shrubs and trees and to threaten small buildings and gardens.

A study of this apparent chaos of topography, plant life and wind action, reveals certain fundamental principles and radically different types of environment which are subject to variation and change from time to time. The most important types of environment are: (1) The type within the limit of salt water which prevents the growth of land plants. (2) The type resulting from the deposition of sand by the wind, such as are found on the lee side of every cluster of plants and opposite every break in a dune; here we find such plants as can withstand partial burying and grow as rapidly as the sand accumulates and trailing vines which maintain their anchorage while their long stems ride over it. (3) The type in which the sand is removed by the wind and the vegetation consists of old individual plants which were established before the excavation started. (4) The type in which the surface of the sand is stationary and the mass effect of the many species of plants is to maintain its stability.

The variations in the amount and general appearance of the vegetation on these sand dunes is due to the variations in these four types of environment. The force of the wind and the rapidity of

the movement of the sand will naturally influence the number of species and the number and size of the individual plants of each species. The vegetation will necessarily be sparse and limited to those species which can endure the unusual stress of wind and sand.

1. THE BEACH VEGETATION

The shore of the north coast throughout the Tertiary formation had a sandy beach of varying width which is occasionally broken by the headlands of the San Juan formation and by the estuaries of the many rivers. The plant life of this beach is practically the same as that previously described, except that it is somewhat more sparse as the result of greater wind and wave action, which has reduced the number of plants to the minimum. In many places no plants are to be found below the margin of the dune thickets and in other places the number is small. Probably the most outstanding plant is the yerba de sal (*Philoxerus vermicularis* (L.) Nutt.) (Fig. 10) which is usually established closer to the ocean than other plants. Its prostrate, red, fleshy stems spread over the sands and it is an important factor in the building of small dunes. Associated with it on the beach are the bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.), rooted above the beach and trailing down over it; and the grass matojo de playa (*Sporobolus virginicus* (L.) Kunth), which migrates along the beach by means of shallow rhizomes. There was also scattered individuals of the herbaceous mostacilla del mar (*Cakile lanceolata* (Wild.) O. E. Schulz) and *Diodia maritima* Thonn. The shrubby *Chamaesyce buxifolia* (Lam.) Small is rare.

2. THE *COCCOLOBIS UVIFERA* DUNES

A little above the zone of wave action, the sand is comparatively quiet and several types of dune-forming plants are to be found. One of the first is the shrubby *Chamaesyce buxifolia* (Lam.) Small; another is the herbaceous *Diodia maritima* Thonn., and the sedge *Remirea maritima* Aubl., all of which tend to hold the moving sand and start small dunes which may attain the height of one to three meters. The lee side of these small dunes is favorable for the uva de playa (*Coccolobis uvifera* (L.) Jacq.) which is the most important dune former of this region. Its extensive root system holds the sand and the shade of its broad leaves prevent surface evaporation to some extent and thus holds the sand which is blown under the thicket. Under the protection of this plant, the dunes grow rapidly and frequently unite into ridges (Fig. 12). The spread of this plant gradually forces out many of the pioneer herbaceous plants. Al-

though some other plants have the same habit they are much less important as dune-formers. Some that may be mentioned are: the shrubby borborón (*Scaevola Plumierii* (L.) Vahl.) and icaco (*Chrysobalanus Icaco* L.), both of which are more abundant and more important in other habitats. The tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) is common and forms tangled spreading mats three meters or more in width. When protected by the shade of the Coccolobis it grows slender and erect and is soon forced out.

The establishment of the dune is usually followed by a growth of uva de playa (*C. uvifera*), which very rarely reaches its maximum height of 15 meters in the dune environment. Its shade and fallen leaves help to hold moisture and increase the organic content of the soil. Therefore, a new environment is formed in which we find an increase in both number of species and indviduals. Among the latter are the vines noyo (*Ipomoea dissecta* (Jacq.) Pursh), dunguey (*Smilax coriacea* Spreng.), bejuco de costilla (*Serjania polyphylla* (L.) Radlk and the false guaco (*Mikania congesta* DC.). The most characteristic herb is the lirio (*Hymenocallis declinata* (Jacq.) M. Roem.). The introduced species, the cocuisa (*Cordyline guineensis* L. Britton) and the bruja (*Bryophyllum pinnatum* (Lam.) Kurz), are frequent and often form large patches where the shrubs have been removed. Various other species come in from the cultivated grounds near the dunes. Certain other shrubby and arborescent species also appear to a greater or less extent with the uva de playa; the most common are the icaco (*Chrysobalanus Icaco* L.), the roble blanco (*Tabebuia pallida* Miers), the palo de María (*Calophyllum antillanum* Britton), the palo de burro (*Capparis flexuosa* L.) and the escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.). None of these attains a large size or surpasses the general level of the uva de playa because of the exposure to continuous winds which checks the growth at a uniform level of about one meter. The vine species of the more exposed situation, such as the bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.) and the mato de playa (*Canavali maritima* (Aubl.) Thou.) trail over the occasional exposed places in the thickets where they are often associated with batatilla (*Ipomoea stolonifera* (Cyrill.) Poir). Here the first colonizers are the shrubs (*Diodia maritima* (Thonn) the sedge (*Remirea maritima* Aubl.), the shrub (*Chamaesyce buxifolia* (Lam.) Small) and the vines batatilla (*Ipomoea stolonifera* (Cyrill.) Poir), bejuco de playa (*I. Pes-caprae* (L.) Roth.) and the mato de playa (*Canavali maritima* (Aubl.) Thou.).

3 THE LEE SLOPE THICKETS

The lee side of the growing dunes has a considerable protection from the winds and is favorable for many plants One of the first arrivals is the herbaceous *Diodia maritima* Thonn, the sedge (*Remirea maritima* Aubl), the shrub (*Chamaesyce buxifolia* (Lam) Small.), the vine batatilla (*Ipomoea stolonifera* (Cyrill) Poir) and scattered trailing individual of such plants as bejuco de playa (*I Pes-caprae* (L) Roth) and mato de playa (*Canavali maritima* (Aubl) Thou) As the dune approaches the maximum in size and the lee side becomes stabilized, this sparse growth develops into a dense thicket in which the uva de playa (*Coccolobis uvifera* (L) Jacq) is usually the most prominent although it is occasionally replaced by other species The stabilization of the lee slope leads to the conservation of the soil moisture, the addition of organic material and thickets which are taller, denser and composed of more species than the thickets of the ridges The uva de playa which does not exceed a meter in height on the ridge, rises to the level of the ridge where its progress is checked by the force of the wind (Fig 11) In fact the entire association of the lee side of the dunes tends to grow to a greater height than the same species growing in exposed places, and some new species, such as mangle botón (*Conocarpus erecta* L), ventura (*Ichthyomethia piscipula* (L) Hitchc) and the shrubby jayajabico (*Erithalis fruticosa* L) are introduced The almendra (*Terminalia Catappa* L) Fig 13, is used extensively for windbreak and its seedlings are usually to be found in considerable numbers on the lee slope of these dunes. They mingle to some extent with the uva de playa and become most abundant where the original vegetation has been destroyed This species is also influenced by the wind, it seldon rises above the crest of the dunes and when exposed to the force of the wind shows a much greater branch development on the south than on the north side With the growth of the thickets, the vines persist but herbaceous plants are reduced in number or disappear When the shrubby growth is removed, the herbaceous weeds from neighboring fields and gardens come in very promptly

4 THE DUNE FORESTS

It is difficult to trace the later development of these dune thickets, as they are cut over as soon as the new growth is large enough for fuel However, it appears that the natural introduction of forest species would gradually overcome the uva de playa and its shrubby

association and give rise to a mixed forest. Some of these species are: the conspicuous almácigo (*Elaphrium simaruba* (L.) Rose), the cenizo or espinosa (*Zanthoxylum martinicense* (Lam.) DC.) and the maray-maray (*Ecastophyllum Ecastophyllum* (L.) Britton). Intermingled with these are to be found the vines, mato azul (*Guilandina crista* (L.) Small) and bejuco de toro (*Stigmaphyllon tomentosum* (Desf.) Ndz.). There are also scattered plants of *Zamia latifoliolata* Preneloup. Most of these species are represented in the second-growth thickets of the limestone hills and there is reason to believe that the stabilized dunes of the San Juan formation were originally covered with a mesophytic forest similar to that of the older limestones.

The dune history may be summarized as follows: When the sand near the beach becomes sufficiently quiet to support plant life, it is more or less completely covered by the pioneer herbaceous species which soon give way to thickets of uva de playa. As the environment improves, new species are added, leading ultimately to a mixed forest. The occupation of the windward side of the dune by plant life is less complete than the summit and lee side because of its greater exposure to the wind. It is in these exposed places that the uva de playa will persist and that we find such plants as the grass, matojo de playa (*Sporobolus virginicus* (L.) Kunth) and the yerba de sal (*Philoxerus vermicularis* (L.) Nutt.) as the outpost plants in space just as they were the first plant in time.

5 SECONDARY SUCCESSIONS ON THE DUNES

Many dunes are destroyed before reaching maturity, sometimes by the removal of the sand when there is not enough plant life to hold it and sometimes by the too rapid deposition of sand When a mature dune is completely occupied by plant life it is quite permanent unless a subsidence of the area exposes it to the action of the waves, or the vegetation is removed by man or other agents. A well-worn path across the top of a dune may permit the removal of sand by the wind and cause the undermining and destruction of the plant life. The destruction of a dune by the wind results in a new dune on the lee side of the old one. Every stage of destruction and construction can be observed along our north coast. In a few cases in which the destruction is caused by wave action, the attack is at the base of the windward side of the dune, resulting in low, steep cliffs of sand held in place by the roots of uva de playa and favoring the growth of the yerba de sal (*Philoxerus vermicularis*

(L.) Nutt.). In most cases the destruction starts with a break in the plant life on the crest of the dune. The sand is removed from this break and poured over the lee side where it forms an active lee slope. The break widens and the plants on its sides are undermined, but the action is retarded by the uva de playa and its associated species. If this continues the old dunes are completely destroyed and new ones formed slightly farther from the shore (Fig. 14). In these cases the moving sands frequently bury the old dune thickets. Some few species are able to withstand this action to some extent, such as the tree Santa María (*Calophyllum antillanum* Britton). The bejuco de costilla (*Serjania polyphylla* (L.) Radlk.) is also resistant and is frequently found twining over partly buried thickets. The mato de playa (*Canavali maritima* (Aubl.) Thou.) appears to thrive under these conditions and is found rooting at the edge of the lee slope and trailing over it. A grass (*Cenchrus carolinianus* Walt.) and some other herbaceous species are less frequent.

The rapid removal of the sand in front of a break results in a flat beach which is nearly or entirely devoid of plants. It is difficult to determine whether the small dunes on these flats are old or new. However, the old dunes are usually recognized by the uva de playa and other plants which are larger than is necessary to hold the small amount of sand and which indicate that the dunes are decreasing in size; while the young dunes are occupied by small plants. The uva de playa being the most common species of the stabilized dunes is very naturally the most common on the disintegrating dunes, although other plants are also present. They are the shrubs, clavelón de playa (*Borrichia arborescens* (L.) DC.) and borborón de playa (*Scaevola Plumierii* (L.) Vahl.) and the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.). Even though such dunes are being destroyed by erosion on the windward side, they continue to collect sand in their lee and that area of deposition is at once occupied by the sedge (*Remirea maritima* Aubl.), the herb (*Diodia maritima* Thonn.), the bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.) and other plants of the habitat. In one case a plant of cariaquillo de Santa María (*Lantana involucrata* L.) was noted, a species which is most abundant on solid limestone.

All these activities in dune formation must be regarded as temporary. They may overrun fields (Fig. 15) and destroy plant life but they are finally stabilized. Eventually the supply of sea-sand is exhausted in a particular locality, the dune ridges protect the territory on the lee side and vegetation is stabilized. The compound

series of dune ridges along our north shores indicates that dune formation, destruction, and reformation and recapture by vegetation has occurred repeatedly in the past.

6 THE VEGETATION OF THE SAN JUAN CONSOLIDATED DUNES

The sand under the dense thickets tends to become firm and solid and there is reason to believe that this is the first step in the consolidation into limestone by means of an organic binder. It is probable that the San Juan formation (Fig. 9) started in this manner although many thousands of years were required for its completion, and the vegetation of prehistoric time may have been quite different from that of today.

The consolidation into the San Juan formation must have been preceded by a stabilization of sand dunes and must have been dependent on the vegetation of that period. It also appears that the plant life of the limestone rock and that of the stabilized dunes must have been similar. The thin soil of the San Juan limestone of today is the result of the disintegration of that formation into a sand which has been modified by leaching and by the addition of organic material. This soil is practically the same as that of the newly stabilized dunes. The plant life of the new and old dune series is very similar but the additional species on the San Juan dunes indicates a greater and larger stabilization of the soil and a greater accumulation of organic material.

The agencies which have had some influence on the plant life of the crest and sides of the dunes attain their greatest efficiency in the intervening valleys where erosion from the slopes has formed a deep, rich soil. It is practically impossible to tell the nature of the plant life of these valleys and slopes before it was removed by man and the land utilized for agriculture. However, two summits unfit for agriculture are still occupied by remnants of the original vegetation, although they have been cut over repeatedly.

The present vegetation is a dense thicket of shrubs, young trees and vines with a few herbs, in which the shrubby icaco (*Chrysobalanus Icaco* L.) is by far the most abundant, forming almost impenetrable thickets around the margin and in all parts of this area. A few plants of the uva de playa (*Coccolobis uvifera* (L.) Jacq.) still persist in the more exposed places where it is difficult for other plants to get a foothold. Many other species which are characteristic of the active dunes show the similiarity in environmental conditions but many additional species also accur. Among the more common are such trees as palo de María (*Calophyllum antillanum*

Britton), palo de burro (*Capparis flexuosa* L.), roble blanco (*Tabebuia pallida* Miers), and limoncillo de monte (*Calyptranthes Sintenisii* Kiaersk.); the shubby berenjena de playa (*Solanum persicifolium* Dunal); the vine pega palo (*Distictis lactiflora* (Vahl) DC.), the chew stick or soap stick (*Gouania lupuloides* (L.) Urban) bejuco de costilla (*Serjania polyphylla* (L.) Radlk.), the bejuco de palma (*Trichostigma octandrum* (L.) H. Walt.), the aguinaldo de blanco (*Jacquemontia nodiflora* (Desv.) G. Don.) the herbaceous botón blanco (*Borreria verticillata* (L.) Meyer), the carmín (*Rivina humilis* L.), the maya (*Bromelia Pinguin* L.), and the bruja (*Bryophyllum pinnatum* (Lam.) Kurz). These herbs are most common around the margin and the madre selva (*Pilea microphylla* (L.) Liebm.) and (*Clavenna tetandra* (L.) Standl.) and other herbs are also quite common. The tall trunks of the almácigo (*Elaphrium simaruba* (L.) Rose) are conspicuous on the summits and jagüey (*Ficus laevigata* Vahl) and cupey (*Clusia rosea* Jacq.) are common on the shady north slopes where the conditions are decidedly mesophytic. The two most common vines are the gungulén (*Vanilla Eggersii* Rolfe and calabazón (*Philodendron Krebsii* Schott) The viney pitalaya or night-blooming cereus (*Hylocereus trigonus* (Haw.) Safford · is common on the trees and the flor de culebra (*Anthurium acaule* (Jacq.) Schott) forms large clumps on the exposed ledges. The striking similarities of these fragments and the thickets of the limestone hills indicate that they represent the same original association which was a mesophytic forest now completely destroyed. It represented the temporary climax of both the mesarch and xerarch successional series.

7 DISINTEGRATION OF THE SAN JUAN DUNES

As previously stated, there were two, possibly three, series of consolidated dunes of the San Juan formation. As the result of a subsidence the second is now in contact with and partly below the level of the sea, and is being disintegrated into sand. This is followed by a retrogressive succession in the plant life. Along the lee front of the outer ridge, clearing and pasturing, aided by the effect of the salt-laden atmosphere, have reduced the original forests to mere thickets, composed largely of thorny species. The most common species in these localities are the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) which forms dense mats; crowded thickets of cariaquillo de Santa María (*Lantana involucrata* L.) and uva de playa (*Coccolobis uvifera* (L.) Jacq.); and tangled masses of the vine, mato azul (*Guilandina crista* (L.) Small). Other shrubby and small-

tree species which are more or less common are the coscorran (*Elaeodendrum xylocarpum* (Vent.) DC.), the alelí cimarrón (*Plumiera alba* L.), the espinosa (*Anthacanthus spinosus* (Jacq.) Ness.), the ventura (*Ichthyomethia piscipula* (L.) Hitchc.), the sereno (*Gundlachia corymbosa* (Urban) Britton, the icaco (*Chrysobalanus Icaco* L.) and *Argythamnia candicans* Sw. They are aggregated into dense and almost impenetrable thickets, seldom more than one or two meters high and tangled with vines of pega palo (*Distictis lactiflora* (Vahl) DC.), bejuco de costilla (*Serjania polyphylla* (L.) Radlk.) and bejuco de toro (*Stigmaphyllon tomentosum* (Desv.) Ndz.) The small open places between the thickets are carpeted with a thin sod of grama blanca (*Stenotaphrum secundatum* (Walt.) (Kuntz) and also colonized by numerous weedy species.

Towards the top of the ridge, where there is a full exposure to the wind, many of these species disappear. The wattle (*Eugenia axillaris* (Sw.) Willd.), persists as a small tree or shrub; the sereno (*Gundlachia corymbosa* (Urban) Britton) is the most common shrub and one colony of lirio (*Hymenocallis declinata* (Jacq.) M. Roem.) was noted; the vine, mato azul ((*Guilandina crista* (L.) Small) was rare or entirely absent. The summits of these ridges, where the bases are exposed to the sea, frequently show fissures parallel to the sea, indicating lines along which blocks of stone will be broken off.

The outer slopes are in direct contact with waves which are undercutting and changing them into steep or vertical cliffs (Fig. 16). Caverns are excavated and fissures formed through which the spray shoots to considerable height. Projecting cliffs fall into the sea and are ground into sand. The whole effect is one of disintegration. This process is very evident to the most casual observer but it is also evident that it must be very slow as is indicated by the presence of old Indian carvings in some of the caverns.

The effect on the plant life is evident. Many species disappear, the strongest surviving longest. The flat pockets of sand which are seldom reached by the salt spray support a limited plant life consisting of the two vines bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.) and mato de playa (*Canavali maritima* (Aubl.) Thou.) and the grass, matojo de playa (*Sporobolus virginicus* (L.) Kunth), all of which decrease with the increase of salt water on the lower levels. Seedlings of *Sporobolus virginicus* and dwarfed plants of bellorita (*Erigeron bellioides* DC.) appear even in the small pockets but at the lower level they are quickly destroyed by the salt water. The shrubby uva de playa (*Coccolobis uvifera* (L.) Jacq.), icaco (*Chrysobalanus Icaco* L.), borborón (*Scaevola Plumierii* (L.) Vahl) and

clavelón de playa (*Borrichia arborescens* (L.) DC.), which cling tenaceously to the small fissures on the side of vertical walls, become smaller in size and fewer in number at the lower elevations, where the sea water strikes them more frequently, and eventually cling only to crevices on the lee side of the walls. Clavelón de playa (*Borrichia arborescens* (L.) DC.) seems to extend farther toward the ocean than any other species.

Breaks in the San Juan formation may be seen at many points along the north coast. They range from a few meters to a kilometer or more in width and some of them are very old. When these breaks are cut low enough for the penetration of sea water a more or less semi-circular bay (Fig. 9) is formed on the land side. The wind sweeping though these breaks causes some destruction of the plant life on the lee side of the dune ridge (Fig. 17). Salt water dashing over the summits of the lower ridges also aids in the work of destruction. Under these trying conditions the uva de playa (*Coccolobis uvifera* (L.) Jacq.) Fig. 18) and clavelón de playa (*Borrichia arborescens* (L.) DC.) appear to be the hardiest species. But even here each layer of sand is occupied by that small but sturdy pioneer grass (*Sporobolus virginicus* (L.) Kunth) and by the shrubby temporana (*Suriana maritima* L.). However, the whole process is that of destruction of the rock and the vegetation.

9. SUMMARY

The sands deposited on the beach by the waves are carried inland by the winds. The xerophytic plants start a xerarch successional series which stabilizes the moving sand into dunes. This growth is characterized by the uva de playa (*Coccolobis uvifera* (L.) Jacq.) and associated species. This reduces the exposure to the wind, conserves moisture and adds organic matter to the sands, and thereby favors the incoming of other species and the formation of dune thickets. Occasional breaks in the dunes lead to the destruction of some of these thickets and the reversion of the plant life to the original pioneer stage. Eventually this dune formation is consolidated into limestone and covered with mesophytic forest. Submergence of the land exposes this formation to the waves which results in a greater or less destruction of both rock and vegetation. The forests are reduced to thickets which are finally destroyed. The sand which is formed as a result of this disintegration is washed ashore, blown inland and contributes to the formation of new dunes. The natural tendency of the plant life is towards the formation of a

mesophytic forest and this will be hastened by elevation of the coast and retarded by submergence.

C.—Subseries the Vegetation of Icaco Cay

This cay is a small island a few kilometers from Fajardo Playa and is the only cay that we visited It is composed of exceptionally white pure limestone with a beach of very recent sand deposit. The plant life is very different from that of the mainland and is probably typical of the many similar islands in this vicinity Its flora has already been studied by Britton (9)

The island may be described as made up of flat-topped, irregular hills which do not exceed 30 meters above sea level These hills are the result of erosion and include at least three undrained depressions and many sinkholes The rainfall is light, probably not more than 40 inches per year, and the drainage largely into the sink holes The very thin soil is mostly in pits and crevices of the limestone. The western end of the Island is a flat shell about two meters above sea level and is covered with a thin layer of sand The lee side has a sandy beach but the windward side is abrupt The exposure to the influence of the high trade winds is reflected in the plant life

The sandy beaches support a zone of uva de playa (*Coccolobis uvifera* (L) Jacq) and other species which are usually associated with it The original vegetation of the flats near the beaches has been removed and many coconut palms planted Presumably it was similar to the beach thickets previously described but the older parts may have been covered with xerophytic forest On the windward side the uva de playa thickets consist of a narrow strip at the foot of the hill

The largest of the undrained depressions (Fig. 19) previously referred to, contains salt or brackish water and is surrounded by a narrow interrupted zone of mangroves *Rhizophora mangle* L being the predominant species The other two large depressions lie above the sea level and one of them is occupied by the low herbaceous barilla (*Batis maritima* L) and the border zone composed of mangle botón (*Conocarpus erecta* L), the other is completely filled with mangle botón In both cases the conditions favor the leaching out of the salt and the maintenance of moisture by drainage from the surrounding hills These conditions are favorable for a vegetation similar to that of the limestone hills of the mainland and the begining of their association is already seen in the presence of jagüey (*Ficus laevigata* Vahl)

The limestone hills of the cay are covered with a xerophytic

chaparral (Fig. 20), usually not more than two meters in height, which shows the effect of the high trade winds. The cariaquillo de Santa María (*Lantana involucrata* L.) is the dominant species, and is associated with small numbers of other microphyllous shrubs. Among these are the corcho (*Pisonia subcordata* Sw.), the escambrón (*Randia mitis* L.), the manto (*Rhacoma Crossopetalum* L.), the alelí cimarrón (*Plumiera alba* L.), the escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), azúcares (*Jacquinia Barbasco* (Loefl.) Mez), *Jacquinia Berterii* Spreng., *Croton betulinus* Vahl, *Argythamnia candicans* Sw., *Wedelia calycina* L. C. Rich., *Chamaesyce articulata* (Aubl.) Britton, the tres espinosa (*Anthacanthus spinosus* (Jacq.) Nees) and *Bumelia obovata* (Lam.) A. DC., the cacti, sebucán or dildo (*Cephalocereus Royeni* (L.) B. & R.), sebucán (*Leptocereus quadricostatus* (Bello) B. & R.) and tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.). There are few vines such as aguinaldo de costa (*Jacquemontia jamaicensis* (Jacq.) Hall f.) and babiero amarillo (*Urechtites lutea* (L.) Britton), but the herbaceous vegetation is almost entirely wanting.

Along the summit of the limestone hills and fully exposed to the trade winds is a dense thicket of wind swept, one-sided shrubs and small trees of bejuco inglés (*Capparis cynophallophora* L.), palo de burro (*Capparis flexuosa* L.), coscorrón (*Elaeodendrum xylocarpum* (Vent.) DC.), palo bobo (*Pisonia subcordata* Sw.) (Fig. 21), azúcares (*Jacquinia Barbasco* (Loefl.) Mez) and limón (*Strumpfia maritima* Jacq.) (Fig. 22).

In conclusion we may say that the two most striking features of the vegetation are the results of the low rainfall and the high winds. The former tends to cause a dwarfing of the plant life and the latter to give a more or less uniform level and a one sided growth.

D. The Hydrarch Series of the Lagoons and Estuaries

1. The Rivers and Playa Land

The many rivers of the north side of Porto Rico are subject to great variations in the amount of water. Their courses through the narrow valleys of the mountains and limestone hills are tortuous. After passing the last series of hills they flow at nearly sea level and broaden into estuaries. The swift currents of the mountains are greatly reduced and a considerable part of the load of eroded materials is deposited. This action through long periods of time and sometimes favored by elevations or subsidences, has resulted in the formation of extensive areas of alluvial soils or playa lands,

known as the Arecibo silt loam These lands are seldom overflowed and there is reason to believe that they were made by submarine, littoral deposits If so, the first plant life following their uplift above sea level was probably a halophytic vegetation of mangroves. Continued elevation accompanied by a leaching out of the salt made possible a successional series reaching a climax in a mesophytic forest

This forest has been destroyed, but Mr E D Colón, who has seen the last fragments in the vicinity of Barceloneta, tells us that it included the Santa María (*Calophyllum antillanum* Britton), the roble blanco (*Tabebuia pallida* Miers) and many other species. A few trees of these two species still exist in the vicinity At the present time the rivers of this region flow through deep channels and there does not appear to be any succession leading to a forest The quiet waters of these streams contain small colonies of the two types of flor de agua (*Castalia ampla* Salisb and *Piaropus crassipes* (Mart) Britton) At the edge of the stream is a fringe of amphibious vegetation composed of the arrow leaf (*Sagittaria lancifolia* L) and the eneas or cat tails (*Typha angustifolia* L) Thickets of the tall grasses caña de india (*Phragmites Phragmites* (L) Karst) and caña cimarrona (*Gynerium sagittatum* (Aubl) Beauv) are conspicuous but scattered features of the plant life These playa lands are very rich and very fine for agriculture especially the growing of sugar cane

2 AQUATIC VEGETATION OF THE FRESH WATER LAGOONS

Many fresh water lagoons and swamps are characteristic of the north coast They may be the results of the sand dunes which have obstructed the natural drainage or they may be the result of a subsidence which has drowned the mouths of certain rivers and caused the water to collect in the lowland back of the dune ridges Laguna Tortuguero (Fig 24), which covers an area of about 4 by 1½ kilometers to the northwest of Manatí, is the largest of these lakes and the one to which we gave special attention

The quiet waters of these lagoons and the small drainage ditches of the swamp support dense colonies of flor de agua (*Castalia ampla* Salisb). In the shallower waters nearer the shores are frequently found smaller colonies of *Nymphoides Humboldtianum* (HBK) Kuntze The lechuguilla de agua (*Pistia Stratiotes* L) and flor de agua (*Piaropus crassipes* (Mart) Britton) also occur in some places. *Ceratophyllum demersum* L and *Potamogeton fluitans* Roth are the most common floating plants

The cat-tail or eneas (*Typha angustifolia* L.) frequently forms colonies sometimes of many acres. The sedge *Mariscus jamaicensis* (Crantz) Britton is also abundant, forming pure colonies at the shore line or mixing with cat-tails. Very few other plants are associated with these two dominant species but a few plants of the aquatic fern (*Blechnum indicum* Burm.) are scattered among the cat-tails. The cat-tails and sedges are rapid formers of the black mud soil which gradually rises above the water level. They may extend for some distance above water level and probably were originally in contact with the shrub or even the mesophytic forest associations of the playa lands. However, it is impossible to determine this point at present as all the playa lands now are under cane cultivation. In fact this crop is extended as far into the lagoon as specially selected varieties can be grown successfully.

THE MUD BANK VEGETATION

The destruction of the cat-tails and sedges at the margins of the marshes is followed by a secondary association of several mud-loving species (Fig. 25). The soil is always saturated and no species has become dominant in this new association. In fact this association is very likely to be overrun in a short time by the cat-tails and sedges which tend to re-establish themselves.

The predominant species of these mud-banks are slender, erect sedges of which the most abundant is the junco de espiga (*Eleocharis interstincta* (Vahl) R. & S.). Other common sedges are *Fimbristylis complanata* (Retz.) Link, *Rynchospora cyperoides* (Sw.) Mart.), *Eleocharis caribaea* (Rottb.) Blake and a few others of similiar habit. Previous to the establishment of the sedges and between the clumps after establishment are many herbs, such as the creeping yerba de culebra (*Bramia Monnieri* (L.) Drake) with its conspicuous bluish-white flowers. *Hydrocotyle verticillata* Thunb. and the yerba de clavo (*Centella asiatica* (L.) Urban) have similar habits but are less frequent. Scattered plants of cat-tails are also common.

4 THE SAND BANK VEGETATION

The thickets of the white sands of Laguna Tortuguero have already been described. The land occupied by these thickets slopes abruptly to the mud banks and wet sandy beaches which differ greatly in their plant life. The vegetation of the mud-banks is related successionally to the marsh vegetation of the lagoon but the vegetation of the sandy beaches consists of sparse groups of species which represent migrations between the two types of plant life which have no successional relations.

In the open sun in such localities, there is a scattered covering of clumps of the sedge *Scleria hirtella* Sw. and junquito (*Fimbristylis diphylla* (Retz.) Vahl) the shrubby herb yerba de ciénaga (*Aeschynomene sensitiva* Sw.) and occasional plants of various weedy species such as *Vernonia cinerea* (L.) Less. In the shade of the overhanging thickets, the vegetation is even sparser, and the commoner species include such herbaceous plants as yerba de San Martín (*Sauvagesia erecta* L.), camasey de charco (*Acisanthera Acisanthera* (L.) Britton), grasilla (*Setiscapella subulata* (L.) Barnh and *Setiscapella pusilla* (Vahl) Barnh.), *Xyris Jupicai* L. C. Rich, and the orchid *Ibidium tortile* (Sw.) House.

5 THE BEACH THICKETS

The shrubby thickets which lie between the wet beach and the dry sands at Laguna Tortuguero contain an interesting group of species. The water table is well below the surface but the soil moisture is maintained by capillarity, which gives a distinct mesophytic environment. The shrubby growth of these thickets attains a height of from one to five meters and many individuals would soon grow into trees if it were not for the repeated cutting of these areas for fuel. The icaco (*Chrysobalanus Icaco* L.) is the commonest species and grows abundantly on the higher and drier places. The camasey (*Miconia prasina* (Sw.) DC. and *M. racemosa* (Aubl.) DC.) are next in abundance. Other shrubs and trees of importance are the corazón (*Annona glabra* L.), the palo de cucubano (*Guettarda scabra* (L.) Lam. the hoja meñuda (*Eugenia monticola* (Sw.) DC.), badula (*Icacorea guadelupensis* (Duch.) Britton), the escambrón (*Randia mitis* L.) and *Clidemia hirta* (L.) D. Don. The most common vines are the maray-maray (*Ecastophyllum Ecastophyllum* (L.) Britton) and the chiggernit (*Tournefortia hirsutissima* L.). A fern (*Odontosoria aculeata* (L.) J. Smith.) is also quite common. Some of the plants of these thickets are no doubt invaders from neighboring semi-xerophytic thickets, while others indicate a tendency towards a succession by the extinct lowland forest.

6 SUMMARY

The hydrarch series of associations is correlated with the usual physographic process of soil formation and is represented by a series of associations differentiated largely by depth of water table and partly by nature of the soil. The deeper water is occupied by submerged and floating plants, the shallower water by a marsh association of cat-tails and the mariscus sedge, and the land above the water

by a mesophytic forest. Temporary associations follow the disappearance of marsh plants on exposed beaches, or appear between the marshes and the adjacent forests of another successional series. The climax vegetation has been completely destroyed.

E. The Halarch Series of Coastal Swamps

There is every gradation from the seashores exposed to wave and wind where the sand and shingle forms beaches and dunes to the seashores protected from wind and waves. Most of the north coast of Porto Rico is of the former type. However, there are many places of the latter type, which are of two general kinds: (1) The banks of the river estuaries where the salt water is brought in by the tide and produces a saline condition for a considerable distance up stream. (2) The breaks through the dunes which have permitted the sea to overflow the low lands of the lee side, producing more or less extensive salt-water or brackish swamps, lagoons or bays depending on area and depth of water. In the largest of these, such as San Juan harbor and the lagoons east of San Juan, the depth of water may be considerable, but their land-locked position minimizes the effect of the waves. Their formation starts a series of successions which proceeds to a climax through intermediate stages depending on the variations in the salinity of the water.

Most of the swamps of the north coast are of this type and show certain fundamental similarities in their plant life, the variations depending on the differences in area, depth of water, salinity and age of the swamps under consideration. The larger areas show broad expanses of uniform plant life which sometimes covers hundred of acres, while in the smaller areas each plant association is limited. In the large, deep areas of open water, the halophytic vegetation is confined to narrow marginal zones. In the very saline waters the vegetation is distinctly halophytic while in the comparatively fresh water the halophytes are restricted to the shore line and are replaced by associations of the hydrarch series a short distance from the water. In general, the nature of the plant life depends on depth and salinity and the area occupied by each association on the gradient of ground surface; a gradual gradient producing uniform conditions over a large area, with similarly extensive development of each association, and a sharper gradient restricting the various associations to narrow zones parallel to the margin. There are three well-marked associations of this series in Porto Rico and it will be necessary to discuss the relationship between these associations and others of the xerarch and hydrarch series.

1. THE MANGROVE ASSOCIATION

The typical pioneer vegetation of such shores in the tropics is the mangrove or manglares composed of several species representing the first stage in the series. There are several species of mangrove belonging to widely different families. The common name applied to all of them is not due to any taxonomic relationship but to a similarity of habitat and behavior. The mangroves are a distinct ecological unit and not a taxonomic group and most of the features which they possess in common are correlated with their environment. The most remarkable of these features is vivipary. In most species, regardless of their taxonomic relations, the seeds germinate before falling from the tree. As a result of the organic contact between parent and offspring the seedlings reach a large size before they fall from the parent. They are either planted by falling into the mud or they drift until anchored in shallow water by the growing hypocotyl. This habit is well illustrated in the common mangle (*Rhizophora mangle* L.). The germination of the seed is followed by a comparatively slight enlargement of the cotyledons and a very conspicuous growth of the long, fusiform hypocotyl which may attain a length of two or three decimeters and a diameter of two or three centimeters. These young plants remain attached to the parent plant for a year before falling into the water where they are easily anchored in the mud in an upright position. They may be anchored near the parent or carried by a current for a long distance. When once established they also develop prop roots. Sometimes these prop-roots grow from branches as much as five meters above the water. These roots eventually reach to the water and mud and form a tangle and covert the colony into an almost impassible thicket. The mangle bobo (*Avicennia nitida* Jacq.) and some other species produce specialized roots which grow vertically upward into the air. These roots are known as pneumatophores and function in the transportation of oxygen.

The leaves of the mangroves are also fairly constant in shape and structure. In our Porto Rican species they are elliptical, or nearly so; smooth, dark green, thick, and assume a more or less vertical position. All of these characters appear to be correlated with the physiological factors of their environment.

The mangroves are exceptionally good land builders. Their crowded stems, aerial roots and numerous pneumatophores retard or stop the movements of the sea waters and the suspended material is dropped among them. Since these plants are confined to still waters, the suspended materials are mostly silt and clay which results

in deposits of mud. The falling leaves and twigs decay and add organic matter, thus making a black mud. With the accumulation of soil, the plants are forced seaward, the rate of progress depending on the depth of the water.

In Porto Rico we have four species of mangrove (Fig 26); the common mangle or mangle zapatera (*Rhizophora mangle* L.), the mangle blanco (*Laguncularia racemosa* (L.) Gaertn.), the mangle bobo (*Avicennia nitida* Jacq.) and the mangle botón (*Conocarpus erecta* L.). As previously stated, the common name of "Mangrove" refers to their ecological and not to this taxonomic relationship. The first three are of the greatest importance and are limited to the mangrove swamps. The fourth is smaller in size, comparatively unimportant in the swamps and more abundant in other habitats. These various species differ in their salt requirement: the common mangle (*R. mangle* L.) requires the highest concentration and is found very close to the ocean. The mangle blanco (*L. racemosa* (L.) Gaertn.) and mangle bobo (*A. nitida* Jacq.) are associated with it but are most abundant on the land side where the concentration is less. The mangle botón (*C. erecta* L.) also grows on the land side of the swamps but extends inland and into habitats which are free from salt water. The first three also require an abundance of free water and thrive only in a saturated soil, while the fourth will thrive in much drier conditions. Therefore, it is most abundant in the drained swamps and on the landward margin and is sometimes found on sand dunes and limestone rocks.

Ordinarily, the mangrove swamps consist of pure stands of the first three or of all four species with no secondary species but a reduction in salinity leads to the incoming of other species, such as the cadillo de ciénaga (*Malache scabra* B. Vogel) which grows to a height of two meters and forms dense thickets in the narrow channels (Fig. 23) of the swamps. The mahoe (*Pariti tiliaceum* (L.) St. Hil.) is a widely branching shrub or small tree, as much as five meters high and is occasionally found growing in the open places among the mangroves or extending over the channels. The palo de hoz (*Drepanocarpus lunatus* L. f.) G. F. W. Meyer) is a stiff, thorny, sparsely branched shrub attaining a height of five meters and arching out into the open sunlight above the canals.

The mangroves are an important source of fuel and their high economic value is fully recognized. They occupy hundreds of acres at sea level which cannot be drained except by the most expensive methods and yield a regular annual income. After cutting, they re-establish themselves easily and quickly.

2 THE ACROSTICHUM ASSOCIATION

One of the most familiar types of vegetation along the north coast is the tall fern (*Acrostichum aureum* L.), growing in long zones or in irregular patches (Fig 27), which may be of several acres in extent on the landward margins of the mangrove swamps. This soil is usually somewhat drier because of its full exposure to wind and sun and always less impregnated with salt. The fern grows in crowded masses a meter or more in height and forms an almost pure stand, secondary species being missing or so few in numbers as to be of no ecological importance. The position of this association in the successional series is not clear. Its great abundance and uniform development in so many different localities and the regularity of its position in close contact with the mangroves, but in slightly drier or less saline environment, leads to the conclusion that it normally follows the mangrove. However, there are reasons, based on general ecological experiences or actual conditions in Porto Rico, for considering it as a temporary or secondary development. This fern thrives exceptionally well in mangrove swamps which have been cut over for fuel and in which the new growth in seldom more than five meters in height. In fact it is frequently found growing in the cleared portion of swamps where the mangroves have failed to re-establish themselves. The succession of a forest type of plant life by a herbaceous type, except as the result of some catastrophe, is unusual and not to be expected in Porto Rico where the climatic conditions of the north shore favor the development of a forest. Furthermore, young mangroves frequently grow in abundance around the margin of the fern association, where the sharp transition line, indicates that the succession at the present is proceeding in another direction.

Acrostichum aureum L. (Fig. 28) is physiologically adapted to the salty or brackish soils of the mangrove swamps, as few other herbaceous species are adapted. It produces enormous numbers of microscopic spores which are no doubt widely distributed over the coastal plain every year but seldom grow in any locality other than the high, open places of the mangrove swamps where they have a good light exposure and do not come in direct contact with the salt water. Under ordinary conditions it grows as scattered individuals and does not form an association, but if the mangrove trees are cut out over an area slightly above sea level, the very place where they are most likely to be cut because of working conditions, this fern forms a dense association. Its density retards the invasion of the mangroves except around the edge, where the ferns can be

gradually shaded out by the overhanging branches thus permitting the mangroves to advance slowly and eventually reoccupy the entire area

3 THE *PTEROCARPUS OFFICINALIS* ASSOCIATION

The only forest of palo de pollo (*Pterocarpus officinalis* Jacq.) is located not far from the shore of the Humacao Playa Although it does not come in direct contact with the typical mangrove swamp, we consider it as representing the next stage in the halarch series. The small rivers of this section come to sea level at a considerable distance from the present shore line The small bays into which they originally emptied are completely filled with a black soil We have reason to believe that these swampy seashore plains were at one time active mangrove swamps With the filling of these small bays and swamps and the development of these flat alluvial plains, sandy beaches were also formed At this point, the beach is about 500 meters wide and is about one meter higher than the alluvial plain farther inland The tides run up the rivers about one half kilometer where contact with fresh water results in the partial damming of the streams and a reduction of the salinity above that point However, their influence is still shown by the scattered mangrove trees along the banks

The reduced salinity as a result of the distance from the sea and the fresh water from the streams produces ideal conditions for a succession from the mangroves because the germination of the seeds and their future growth will be checked by the change in environment and new species will be enabled to invade the territory Such appears to be the history of the Pterocarpus forest There is a deep black muck with the surface slightly above sea level, always wet and soggy and usually treacherous under-foot The muck is shallow near the margins as indicated by the sand turned up in the planting of coconuts This superimposed muck has undoubtedly been formed in a swamp of mangroves, or possibly of other plants, after the formation of the sand bars on the shore side This muck is no doubt increasing as a result of the flooding by the rivers during the rainy periods and accumulation of vegetable matter

The palo de pollo (*Pterocarpus officinalis* Jacq) is the dominant tree (Fig. 29) and in fact almost the only tree of this swamp, although there are a few others such as the royal palm (*Roystonea borinquena* Cook) and a very narrow zone of mangroves (*R mangle* L) along the rivers The trees have been repeatedly cut for fuel and the coppice growth consists of three to six slender trunks from

each stump which rarely exceed 20 meters in height and are usually less than 5 decimeters in diameter The old stumps have exceptionally fine buttress growths, in some cases, the roots are four times as long as high, fairly thin at the base but with curved upper edges and sometimes branching distally They may extend outward as much as five meters from the base of the tree Traces of newly developed buttresses may be found as much as five meters above the ground and the size of the system is very much out of proportion to the size of the trunk, one tree only three decimeters in diameter at four meters above the ground had a buttress development 25 meters in circumference

In addition to the royal palm (*Roystonea borinqueña* Cook) there are a few individuals of two other tree species in this association but they are always small They are the escambrón (*Drepanocarpus lunatus* (L f) G F W Meyer), with its slender trunks one decimeter in diameter and about 10 meters in height, and a few young trees of cupey (*Clusia rosea* Jacq) which are anchored in the tops of the trees or grow as independent plants The shrubby cadillo de ciénaga (*Malache scabra* B Vogel) grows in small thickets and as isolated individuals throughout the forest and attains a height of four meters The bejuco of guajanilla (*Paullinia pinnata* L) is abundant climbing to the tops of the trees, looping from tree to tree and festooning the trunks Some of the other plants worthy of mention are the bejuco de Santiago (*Aristolochia trilobata* L), the paralejo velludo (*Banisteria laurifolia* L), bejuco de prieto (*Hippocratea volubilis* L) and *Stigmaphyllon puberum* (L C Rich) A Juss

The irregular surfaces of the Pterocarpus buttresses and the accumulation of debris upon them forms a most excellent environment for epiphytic plants which are very numerous The largest and most common is the flor de culebra (*Anthurium acaule* (Jacq) Schott) with its dense masses of roots and large rosettes of long leaves which in turn shelters the young of its own species and *Peperomia glabella* (Sw) A Dietr) The large fern (*Polypodium decumanum* Willd) is common and a few individual plants of the fern (*Nephrolepis biserrata* (Sw) Schott) are found on the stumps of the *Pterocarpus* The night blooming cereus or pitajaya (*Hylocereus trigonus* (Haw) Safford) is occasionally seen in the higher trees The fern *Acrostichum aureum* L grows as isolated plants or in small colonies wherever the light is sufficient

Some cuttings have been made along the margin for the purpose of planting coconuts and these places have been quickly occupied by

an exceptionally dense growth of the fern *Acrostichum aureum* L. (Fig 28). The fronds reach a length of more than three meters and are closely interlaced in every direction. In the next outer zone which is planted to coconuts we find a carpet of the yerba de culebra (*Bramia Monnieri* (L.) Drake) and *Nelsonia brunelloides* (Lam.) Kuntze

4. THE CLIMAX FOREST

The Pterocarpus forest has followed the decrease in salinity which was unfavorable for the mangrove growth This decrease will continue with the increase in deposits of alluvium which raise the land higher and higher above the influence of the tide until the environment is similar to that of the playa lands of the north coast Therefore, we have reason to believe that if undisturbed by man, the extinc tforest of the playa would eventually succeed the Pterocarpus association

5. INTERMEDIATE VEGETATION AT FAJARDO PLAYA

We have previously called attention to the wind and wave action of the north coast which causes the formation of sand dunes, the exclusion of vegetation from the wet fore-shore, and the initial stage in the xerophytic plant life of the dunes There must be every possible intermediate stage between the environment and plant life of such a coast and the quiet shores which are inhabited by the mangroves The reduction of the wave action results in the deposition of finer materials and plant life becomes possible at lower levels. The salt content of the soil becomes higher, the lower plants increase in number and the initial vegetation becomes more and more halophytic. At Fajardo Playa the off-shore islands reduce the wave action sufficiently to permit the growth of mangroves at the water edge and gives us an intermediate stage of environment. The waves are strong enough to carry up and deposit the fine sands but it is not blown into dunes, and becomes less and less saline with the increase in distance from the shore The beach has a very gentle slope and is almost completely covered with the common mangle (*Rhizophora mangle* L.), the mangle blanco (*Laguncularia racemosa* (L.) Gaertn.) and the mangle bobo (*Avicennia nitida* Jacq.). A little farther back, this growth is intermingled with the uva de playa (*Coccolobis uvifera* (L.) Jacq.), the chamiso (*Dodonaea viscosa* Jacq.) and the tachuelo or karrebesu (*Pictetia aculeata* (Vahl) Urban) forming dense thickets about 6 meters in height but with little herbaceous plant life (Fig. 30). Still farther inland, *R. mangle* disappears,

I. racemosa, A. nitida become less abundant and the mangle botón (*Conocarpus erecta* L.) appears in quantity; uva de playa (*C. uvifera* (L.) Jacq.) and the tachuelo (*Pictetia aculeata* (Vahl) Urban) continue. The last three become the dominant species over a large area extending a considerable distance from the beach. Other common species are the escambrón (*Randia mitis* L.), the escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), the manto (*Rhacoma Crossopetalum* L.), the ucarillo (*Ginoria Rohrii* (Vahl.) Koehne.), the abejuelo (*Colubrina Colubrina* (Jacq.) Mills.) and the zarza vine (*Mimosa Ceratonia* L.).

This thicket is frequently cut over for fuel but the environment and the plant life are so similar to that of the thickets at Mameyes (page 70) that we believe that this area was formerly covered with a mesophytic forest, which was probably the equivalent to that of the white sands previously described. It is probable that the halarch series which depends on the salinity may be replaced, in a more sandy soil, by members of the xerarch series and the plant life carried to a corresponding conclusion.

6 VEGETATION OF THE CAÑO TIBURONES

This is the largest swamp on the north coast. It occupies an area of about 20 kilometers in length by three kilometers in width and extends from Arecibo on the west to Barceloneta on the east. Its natural outlet is into the Arecibo river at the western end but an artificial drainage system has been opened into the Manatí river at the east end. Much of this area is below sea level and none of it rises more than a few decimeters above the tide. The gradient is too slight for successful drainage and the opening of ditches and canals has facilitated the entrance of tide water and carried the salinity some distance into the interior. The salinity varies from place to place owing to the slow diffusion of salt water through the dense vegetation. Each rise of the tide tends to increase the salinity and each rainfall to reduce it. The removal of the vegetation in places and the exposure of the soil has tended to increase the salinity at the surface by the rise of the water from below and the deposition of salt by evaporation, to that the surface of the soil is frequently whitened by saline incrustations.

The soil is a very black muck formed by the accumulation of silt and the decomposition of decayed swamp vegetation. The water-table is a little above or very little below the surface and the salinity increases from east to west. The character of the vegetation over the eastern two-thirds of the swamp indicates that the soil water was

originally fresh or very slightly saline and that of the western third indicates a salinity resulting from the tide water coming in through the Arecibo river The soil is rich in organic matter but poor in minerals, especially potash.

When viewed from the hills on the north side of the swamp it can be readily seen that the eastern end is level and completely covered with a dense growth of narrow leaved sedges, grasses and cat-tails and a few isolated shrubs and small trees Over the western fourth the plant life is quite different, consisting of a dense growth of a dark green fern with scattered but numerous trees At the extreme western end, the trees become still more numerous, and finally grade into a forest separated by strips of fern The whole area is intersected by artificial canals and ditches of open water

These three associations cover almost all of the western part of the swamp A fourth swamp forest association originally existing at the eastern end has been destroyed and the land is now used for the growing of sugar cane A fifth association has developed in the canals and drainage ditches and a sixth type which can scarcely be dignified as an association appears on the low ridges of the earth excavated in the digging of canals and on the ridges constructed in attempts to increase the area for growing cane

The cat tail sedge association (Fig 25) covers most of the eastern three-fourths of the swamp and consists of a dense mass of narrow-leaved hydrophytes growing so close together that very few other plants can grow beneath them There are three dominant species; the eneas or cat tails (*Typha angustifolia* L) is the most important and covers hundreds of acres with an almost pure stand, the sedge known as serrucho (*Mariscus jamaicensis* (Crantz) Britton) is second in quantity and grows in solid masses, attaining a height of two or three meters and the caña de india (*Phragmites Phragmites* (L) Karst), which forms thickets at wider intervals and attains a height of four or five meters Scattered individuals and small colonies of secondary species are also present The most common is the shrub salvia (*Pluchea odorata* (L) Cass) which is one or two meters in height, and is tall enough to bring its leaves above the general mass of foliage The false guaco (*Mikania congesta* DC) and an *Ipomoea* climb over the taller plants and secure the necessary light exposure. Growing in small open places are the arrow-leaf *Sagittaria lancifolia* L, the sedge junco de espiga (*Eleocharis interstincta* (Vahl) R & S), the herbaceous *Hydrocotyle verticillata* Thumb, the sedge *Dichromena colorata* (L) Hitchc, the yerba de culebra (*Bramia Monnieri* (L) Drake) and other species of the mud association.

About three kilometers from the western end, the above vegetation is replaced by masses of the large fern (*Acrostichum aureum* L.) which grows in an almost pure association over hundreds of acres. This fern, which is characteristic of brackish water, grows in large clumps and its numerous fronds attain a length of two or even three meters These plants grow in such dense masses that there does not appear to be any typical secondary species. There are some scattered individuals of the thorny legume, palo de hoz (*Drepanocarpus lunatus* (L f) G F. W Meyer) with ascending, sparsely branched stems rising above the general level It is more abundant in this association than in the mangrove thickets farther west. Scattered individuals of mangle botón (*Conocarpus erecta* L) also rise above the ferns. A few plants of the *Typha-Mariscus* association of the eastern part of the swamp persist here, including small colonies of the dominant species and patches of caña de india (*Phragmites Phragmites* (L) Karst), but these are always more abundant on the low ridges than elsewhere The opening of the numerous ditches and canals (Fig. 31) has formed areas standing water so nearly fresh that several fresh-water hydrophytes have appeared The most common is the flor de agua (*Castalia ampla* Salisb) Associated with it are scattered colonies of *Potamogeton fluitans* Roth and *Ceratophyllum demersum* L.

The term terreplén is used to designate the low flat ridges formed by the earth thrown up in dredging or in making roads They are 3 to 6 decimeters above the normal level and very few swamp species can grow on them This is especially true where deep cutting has brought the underlying limestone soil to the surface. The vegetation on these terreplén is very sparse even after a lapse of 16 to 18 years The common salvia (*Pluchea odorata* (L.) Cass) has become established on the terreplén and in more abundant than in the swamp where it must compete with the cat-tails and sedges The chief vegetation is composed entirely of adventitious weedy species, among which the herbaceous botón blanco (*Borreria verticillata* (L) Meyer) is most abundant Other species are the maray-maray (*Ecastophyllum Ecastophyllum* (L) Britton), the herbaceous escobita (*Scoparia dulcis* L), the shrubby berenjena cimarrona (*Solanum torvum* Sw), the palo de María (*Calophyllum antillanum* Britton), the jagüey (*Ficus laevigata* Vahl), the corazón (*Annona glabra* L.), the malvavisco (*Corchorus hirtus* L) and the herbaceous manzanilla (*Wedelia trilobata* (L) Hitchs).

If the plant life of this swamp had been undisturbed by man, it is probable that it would lie in the following order from west to

east mangroves, ferns, cat-tails and swamp forest The geologic and physiographic history of this region indicates that the swamp started near the Arecibo river and extended eastward as a result of the submergence of the land This does not necessarily mean that the swamp forest also started at the western end and moved eastward, giving way to the plant life in the west and traveling with the formation of the swamp On the contrary we believe that the first swamp vegetation was a mangrove association on the margin of the young swamp Mangroves are plants of quiet salt water, with means for rapid dispersal, and would naturally start wherever the conditions were favorable

As the swamp increased in size, the mangrove thickets also increased and served to break the tide and reduce the mixing of the salt water with fresh water flowing in from the east In this area of quiet water, ranging from brackish to nearly fresh, the other three associations became established as narrow zones. As the swamp increased in size due to a slow submergence, all the associations spread over larger areas The cat-tails spread most rapidly and finally dominated the greater part of the swamp The early stages in such a formation may now be seen at Palmas Altas where a small mangrove swamp is being established In the San Juan harbor, we find a variation in this history, the water is deeper, there is a greater exposure to tides, and the steeper gradient of the surrounding land has led to a greater development of mangroves and a reduction of the cat-tail, sedge and fern association

The transition at this time between the mangroves and the Acrostichum, and between the Acrostichum and the Typha-Mariscus associations is not caused by a similarly sharp transition in the salinity of the water That decrease is gradual from west to east and should produce an equally gradual change in the vegetation if it were the one decisive factor in the environment Furthermore, the range of tolerance of typical plants is greater than exists in the areas occupied chiefly by them; scattered plants of cat-tails are found in the mangrove zone, ferns are found among the cat-tails and even very close to the canals in which we find such typical fresh-water plants as the flor de agua (*Castalia ampla* Salisb.). The abrupt changes are due to the plants themselves; both the cat-tails and the ferns covering certain areas so completely that mixtures are difficult. It appears probable that the dense growth of these two species produces shading which prevents the germination of seeds and spores. The explanation is certainly true for the mangroves.

Evidence for the prediction of future changes, provided this swamp

should be undisturbed by man, is very slight. At this time it is very evident that there are more colonies of ferns in the cat tail-sedge association than the reverse, which may indicate that the ferns are advancing to the east It is also conceivable that the isolated mangrove plants among the ferns may, if undisturbed, develop into thickets and progress eastward to the limit of their fresh-water toleration It may be that the entire fern area was recently covered with mangroves which have been destroyed by repeated cutting for fuel

The great swamp is almost entirely surrounded by cane fields which have been extended to the limit of cane toleration for saline soil Attempts have been made to extend these fields by throwing the soil into flat ridges separated by channels but the rise of salt by means of capillarity and its accumulation in the surface soil by evaporation have been disastrous for the growing of cane and in many cases have resulted in abandonment of these ridges In these abandoned areas the channels are quickly taken by the cattails and sedges to the very edges of the ridges. The yerba de culebra (*Bramia Monnieri* (L.) Drake) and other plants of the mud-bank association grow on the edges of the old cane beds The surface of the ridges are taken by various weed species, especially the herbaceous *Wedelia trilobata* (L.) Hitchc These muck soils are among the best in Porto Rico for cane growing and their reclamation is a question of time Their location near sea level makes drainage by ordinary methods impossible but it is very probable that other methods will be devised (Fig. 32)

7 SUMMARY

The mangrove swamp is the pioneer association of the halarch series The accumulation of soil reduces the salinity and it is succeeded by the *Pterocarpus* forest, which is in turn succeeded, under natural conditions, by the climax forest The removal of the mangroves leads to the development of a fern (*Acrostichum aureum* L.) association In places intermediate in environment between mangrove and uva de playa associations, these two species make a mixed growth. In the larger lagoons more remote from the ocean where the water is fresh or slightly brackish, the associations belong to the hydrarch series

VEGETATION OF THE CENTRAL MOUNTAIN REGION

The plant life of the northern coastal plain of Porto Rico coincides quite accurately in distribution with the geology and physiography of the region, but the plant life of the southern coast, which is more

or less xerophytic in nature, not only covers the coastal plain but extends up the mountain slopes and over the volcanic soils, reaching its northern limit along a line determined by rainfall and humidity. Therefore, that part of the island lying between the coastal plain on the north and the line just referred to on the south does not include all the ancient volcanic mountain region. On the north, this area extends as far as the Tertiary region; on the west and east to the sea shore, except for small areas of recent maritime or fluvial deposits; on the south to the limits of adequate rainfall. In general, this southern boundary may be designated as a line extending from the Panduras Ridge south of Yabucoa, westward along the southern side of the range at an altitude of about 450 meters (1,500 feet) to Cabo Rojo.

The most important environmental characters of this mountain region, on which the plant life primarily depends, are abundant rainfall, high atmospheric humidity and soils derived from the decomposition of ancient rocks, which are mostly acidic in nature. From this region south until we reach the coastal plain, the soil is practically the same but the rainfall is deficient. The northern boundary coincides with the geological boundary of the north coastal plain and is independent of altitude. At the north-east corner of the island, near Fajardo, the plant life of the mountains descends to sea level. At Lares it reaches is lower limit at about 400 meters (1,200 ft.) above sea level at a point where the Tertiary formations reach their highest altitude. The southern boundary is determined by rainfall and not by geological character of the soil and is fairly well correlated with elevation above sea level; the general altitude being 450 meters (1,500 ft.) gradually dropping to sea level at the eastern and western ends of the Island.

The transition from the plant life of either the northern or southern coastal region into the plant life of the central mountain region can be seen along the insular roads that cross the island from north to south in many places. On the north side we have an abundant rainfall both in the moutains and on the coastal plain and the transition is marked not so much by general appearance of certain species as by species which are restricted to one or the other of these regions. To the casual observer, the most conspicuous of these is a very common roadside fern (*Dicranopteris pectinata* (Willd.) Underw.), which grows in large masses along the highways (Fig. 33), especially on the shady banks. It is restricted to the old soils of the mountain region and is an excellent soil indicator. The beautiful fern tree (*Cyathea arborea* (L.) J. E. Smith) (Fig. 34) is also an important soil

indicator but less abundant and more likely to extend beyond the soil limitation best suited for its growth It is more or less common in elevations above 200 meters (650 ft) and is one of the most attractive features of the landscape They are not so abundant in the fully developed forests as in the thickets along the small brooks and steep slopes The finest specimens are observed above 500 meters (1,500) feet).

Although there are many species that live on both the north coastal plain and the central mountain range, the plant life of the two regions is composed primarily of different species One of the most common species that attracts attention from the highways is the tereiopelo (*Heterotrichum cymosum* (Wendl) Urban), a tall shrub or low tree of the high altitudes Another is the llagrumo (*Didymopanax Morototoni* (Aubl) Dcne & Pl), with its tall slender trunks and large leaves which are dark green above and brown beneath

The southern limit of the mountain vegetation (Fig 35) is determined by rainfall, atmospheric humidity, insolation and wind Its exact location is irregular depending to some slight degree on soil and topography The south slope ravines tend to collect moisture from the run-off and seepage and are less exposed to the drying influence of the sun and wind Therefore the mesophytic plant life of the mountains extends to a lower level in these ravines while the xerophytic plant life of the plain extends to a higher level on the ridges between them This distribution of plant life can be readily seen from the mountain roads which alternatively cross these two types of vegetation

In the low lands at the eastern and western ends of the mountain mass we find areas of alluvial soils and maritime deposits in which the vegetation is not related to the mountains proper It has already been discussed in connection with the northern coastal plain and consists of low sand dunes and mangrove swamps with small areas of *Pterocarpus* forest and second-growth thickets The greater part of the land is utilized for agricultural purpose in the growing of sugar cane, coconuts and other crops

There is a considerable variation of soil within this central mountain region but the most widely distributed surface rocks are tuffs, shales and conglomerates with some andesites, diorites, granites, porphyries and serpentines A careful study would probably show some relationship between these soils and the plant life but it was impossible for us to do more in the alloted time than note a few species which appeared to be localized on the serpentine soil. The more common and dominant tree species and the general composition of

the plant life does not show any relation to the geology of the region.

The rugged character of the country has already received consideration. Practically all of the available land is now used for some kind of agriculture, but the narrow valleys and precipitous hillsides still show some native vegetation although they have been cut over for building material and fuel or used for pasture to a greater or less degree. Large areas in the higher elevations are used for growing coffee and have been planted to shade trees of guama (*Inga laurina* (Sw.) Willd.) and guaba (*Inga Inga* (L.) Britton) which give the appearance of a natural forest. Diseases of the coffee plants have resulted in the abandonment of many estates which eventually revert to the native forest, but it is doubtful if any of these secondary forests have yet reached such a condition that they can be used to illustrate the original mountain vegetation.

The Luquillo Forest Reserve at the eastern end and the Insular Forest near Maricao at the western end contain many large individual trees and colonies of valuable economic species and there is evidence that the cuttings which they have received from time to time have not been so extensive as to seriously interfere with the general composition of the plant life. At some other points, notably near Adjuntas and Jayuya, the mountains rise above the limit of successful coffee growing and are occupied by fragments of the original forest which have been modified to some extent by cutting. These mountain forests originally extended to sea level at both eastern and western ends of the Island but these lower altitudes have been almost completely deforested. A few small areas, very much marred by selective cutting, remain at Ceiba and Humacao and have given us some data for this survey.

It is extremely difficult to characterize definite plant associations from a study of these widely separated tracts, some of which have been very much modified by man. However, we believe that there were five major associations of the mountain region as follows: (1) mountain forests of the low elevations, (2) the moist tropical forest, (3) the rain forests of the Luquillo Mountains, (4) the Sierra palm forests, and (5) the mossy forest.

1 THE MOUNTAIN FORESTS AT LOW ELEVATIONS

The forests of the central mountain range originally descended to very low elevations and possibly to the sea level at points near the eastern and western ends of the Island. East of San Juan the coastal plain is narrow or interrupted and even at Río Piedras the rolling hills of the Cretaceous age rise almost from sea level. From

Canóvanas east and south to Maunabo the mountains descend to the ocean except where broken by the playas (Fig. 36) or the many small rivers. At the western end of the Island, geological formations of the same age, and subject to similar interruptions, occupy the coast line from near Aguadilla south to Cabo Rojo.

Owing to the utilization of the lower hills for agriculture, the native vegetation is almost entirely limited to small zones along the streams, fence rows, roadsides, and small thickets on rocky outcrops and slopes too steep for agriculture or pasture. These small areas give a very imperfect idea of the composition of the original forest. The best remaining areas of the original forests are near Ceiba. One of these was in virgin condition until recently when the most valuable trees were removed. It is now a dense jungle of young trees. Near this place one small area of flat ground contains a few trees of cobana (*Stahlia monosperma* (Tul.) Urban), which is almost extinct in many parts of the Island; also a few trees of bucar (*Bucida Buceras* L.) and ceiba (*Ceiba pentandra* (L.) Gaertn.). The cobana usually has a crooked bole branching a short distance above ground into a low round head. A few individuals are known at other places along the south coast. These species indicate a considerable degree of ecological similarity between the two regions of the Island, notwithstanding the great variation in the amount of rainfall. This similarity is also indicated by the shrubs which grow along the landward side of the mangrove association, such as the palo de burro (*Capparis flexuosa* L.), the bariaco (*Krugiodendron ferreum* (Vahl) Urban), the coscorran (*Elaeodendrum xylocarpum* (Vent.) DC), the jiba (*Shaefferia frutescens* Jacq.), as well as such common vines as the bejuco de costilla (*Serjania polyphylla* (L.) Radlk.), the zarza (*Acacia riparia* HBK.) and *Gouania lupuloides* (L.) Urban, all of which are found also in the arid southern coastal plain.

Scattered trees of the original forest on the hills indicate that its general height was 20 to 30 meters, but give no idea of its density or the relative number of species. The arborescent species observed included the tamarindo cimarrón (*Acacia muricata* (L.) Willd.), the almácigo (*Elaphrium Simaruba* (L.) Rose), the cobana (*Stahlia monosperma* (Tul.) Urban), the jiba (*Schaefferia frutescens* Jacq.), the tachuelo (*Pictetia aculeata* (Vahl) Urban, the bucar (*Bucida Buceras* L.), the bejuco inglés (*Capparis cynophallophora* L.), the corcho (*Torrubia fragans* (Dum. Cours.) Standley), the palo de muñeca (*Cordia glabra* L.) and the *Capparis coccolobifolia* Mart., and tea (*Amyris elemifera* L.). The almácigo, which is so worthless that is not cut, is the only one that reaches the normal height. The others

are limited to small trees seldom more than 10 meters in height, straight, erect and densely crowded into an almost impassable thicket. Associated with these trees and frequently nearly equaling them in size, is an assemblage of shrubs, including palo de burro (*Capparis flexuosa* L.), escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), escambrón (*Randia mitis* L.), the alelí cimarrón (*Plumiera alba* L.), granadillo (*Eugenia ligustrina* (Sw.) Willd.), hoja meñuda (*E. monticola* (Sw.) DC.), quiebra hacha (*E. pseudopsidium* Jacq.), burro blanco (*Capparis portoricensis* Urban), *Neea buxifolia* (Hook. f.) Heimerl, *Eugenia cordata* (Sw.) DC., and *Psychotria pinularis* Sessé & Moc. There are also a few under-shrubs, such as *Argythamnia candicans* Sw., *Ditaxis fasciculata* Vahl, *Catesbaea parviflora* Sw. and the añil falso (*Benthamantha caribaea* (Jacq.) Kuntze.). Among the vines, the grass (*Lasiacis divaricata* (L.) Hitchc.) is very abundant and forms large tangled masses on the taller vegetation. Other abundant vines are the liana uñada (*Batocydia Unguis* (L.) Mart.), the bejuco de costilla (*Serjania polyphylla* (L.) Radlk.), the dunguey (*Smilax coriacea* Spreng.) and *Gouania lupuloides* (L.) Urban. Here again the strong floristic affinity to the arid woodlands of the southern coast becomes apparent although the general conformation of the plant life is different.

Farther back from the coast near Ceiba, the same type of plant life is essentially repeated although selective cutting has reduced the number of tree species and changed the composition of the forest. Here as at the coast, the bucar (*Bucida Buceras* L.), the almácigo (*Elaphrium Simaruba* (L.) Jacq.), the tachuelo (*Pictetia aculeata* (Vahl) Urban) are the common species. The bálsamo (*Citharexylum fruticosum* L.) and palo bobo (*Pisonia subcordata* Sw.) are additional species of xerophytic affinity, while malagueta (*Amomis caryophyllata* (Jacq.) Krug & Urban) and cenizo (*Zanthoxylum martinicense* (Lam.) DC.) indicate a mesophytic tendency. This mesophytic tendency is also illustrated by the herb, bijao (*Alpinia aromatica* Aubl.) and by the two ferns *Dryopteris subtetragosa* (Link) Maxon and *Dryopteris pedata* (L.) Fée.

A similar plant life exists at Humacao although more severe cutting has greatly reduced the number of tree species, which have been replaced by a greater development of shrubs. *Miconia Thomasiana* DC. is especially abundant. Most of the trees and shrubs are sclerophyllous, which is probably the result of a decrease in rainfall and atmospheric humidity.

It is extremely difficult to give any satisfactory discussion as to the character of the original forest from a study of these few, much-

modified fragments. The only remaining species of full size is the worthless almácigo (*Elaphrium Simaruba* (L.) Rose), which is of no ecological significance. The xerophytic tendency of many of the species and their occurrence on the arid southern side of the Island is noteworthy, but they may have formed a small and very unimportant part of the original forest. It is reasonable to suppose that the original forest may have been distinctly mesophytic and that the clearing followed by exposure of the soil to wind and sun resulted in the establishment of the xerophytic species listed above. It is very probable that if undisturbed by man, they might shelter and encourage the return of a normal mesophytic species.

2 MOUNTAIN FOREST AT HIGHER ALTITUDE

The central mountain range above the low altitude forests which we have just discussed was originally covered with a luxuriant forest of an exceptionally large number of species. Gifford has placed its lower limit at about 150 meters and its upper limit as indicated by the few remaining fragments must have been about 600 meters (2,000 ft.) in the Luquillo Mountains and about 900 meters (3,000 ft.) in the Central Cordillera. Therefore, it covered the greater part of the mountain region, since the mountains rise above 900 meters in very few places. Its range was practically the same as that of successful coffee cultivation. It also covered the San Lorenzo and Cayey valleys which are now utilized in the growing of tobacco and also several areas now used for other crops.

This original forest has been almost entirely destroyed. The aborigines probably cleared small areas for their crude agriculture but Murphy believes that the most rapid destruction did not start until the nineteenth century when there was a demand for land for the growing of coffee. Beginning at about this time, there was a rapid increase in population, which has not yet ceased, and which increased the demand for building material and fuel and later led to the utilization of practically all of the available land for agricultural purposes.

Fortunately, a few areas escaped this period of destruction. The largest area includes several thousand acres of what was originally crown land which was set aside by the United States Government as the Luquillo Forest Reserve. This region shows no indication of having been cut over and used for agriculture but many valuable trees were evidently removed. A second area of considerable size lies south of Maricao and comprises the Insular Forest Reserve. There are some other privately owned small tracts on the higher slopes of

the Central Cordillera in the valley of Jayuya and Adjuntas but they have been modified by selective cutting or lie above the limits of the region of the Sierra Palm or mossy forests

At many places there is a second-growth forest development following the abandonment of coffee cultivation, but the dominant species are the guamá (*Inga laurina* (Sw) Willd) and the guaba (*Inga Inga* (L) Britton) which were used for coffee shade, with a mixture of the more mobile species of trees and undergrowth If undisturbed, there will be gradual migrations which will tend towards the re-establishment of the original forests, but this will probably require centuries for its completion

Many apparent forest areas can be seen from the highways but they are mostly coffee plantations in which the guamá and guaba dominate Most of the region is composed of steep hillsides and narrow valleys mostly occupied by cities, villages, pasture lands and various kinds of agriculture The royal palm is common and there are many second-growth thickets containing llagrumo (*Cecropia peltata* L), grayumo or llagrumo macho (*Didymopanax Morototoni* (Aubl) Decne & Pl), tree ferns (*Cyathea arborea* (L) J E Smith), cupey (*Clusia rosea* Jacq) and a few species of *Piper* and *Miconia* (Fig 34)

Fragments of the original mountain flora are still to be seen throughout the region The common fern (*Dicranopteris bifida* (Willd) Maxon) grows in masses on the recently made road banks. The shrubby terciopelo (*Heterotrichum cymosum* (Wendl) Urban) and the several species of *Miconia* furnish shade for woodland ferns and many delicate plants *Begonia decandra* Pav and *Hillia parasitica* Jacq (Fig 37) are occasional, epiphytic orchids bloom on some of the trees and the introduced raspberry or fresa (*Rubus rosaefolius* Smith) grows in great abundance in many places

The wide-spread destruction of this original forest made it necessary for us to restrict our studies almost entirely to the Luquillo Forest Reserve, the Insular Forest Reserve at Maricao and the region around Jayuya The most superficial study shows that these tracts differ ecologically and that these differences are due primarily to variations in rainfall and atmospheric humidity The Luquillo Mountains near the northeast corner of the Island have an altitude of about 1 050 meters, are fully exposed to the moisture-laden trade winds from the northeast and have the highest rainfall of any point on the Island, amounting to probably 350 centimeters (140 inches) or more per year Droughts are unknown and there are few days without rain Cloudiness is above the average and the vegetation is frequently

drenched with condensed moisture These conditions give rise to the development of a true rain forest At Maricao the rainfall is less than 250 centimeters (100 inches), sunny days are more frequent, and droughts occasionally last long enough to have some effect on the forest The natural vegetation approaches the type described by Schimper as a monsoon forest There is no well-defined dry season but the abundance of vines and epiphytes and less luxuriant growth justify its classification as a moist tropical forest Forests of this type probably extended originally over most or possibly all the central mountain range of the upper altitude, except the Luquillo Mountains which were covered by the rain forest to which we have referred

A The Moist Tropical Forest

When this forest is viewed from above, it is seen to be composed of trees of various heights and color, with a mottling of mosaic shades of green due to difference in species and age of foliage There are very few trees with trunks of a meter or more in diameter, the crowns are narrow and sparcely branched and the bark on most species smooth Many trunks show a pronounced basal flare One of the most striking environmental features is the scanty development of humus The ground is covered with a thin layer of leaves and twigs and a very thin layer of humus below which the soil is stained black for a few centimeters This is probably due to the gradual fall of leaves throughout the year, the rapid oxidation of organic matter, and its rapid removal by the heavy rainfall There are many tree species and very few individuals of each, which are usually widely scattered throughout the forest It was impossible to make any statistical studies in the short time available for the work but we have made use of the information on this phase of the subject which was given us by Mr W J Kramer and Mr C Z Bates of the Forest Service

The two most conspicuous tree species are the jácana (*Lucuma multiflora* (A DC) and the guara guadillo (*Guarea ramiflora* Vent), although large individuals are not common, their seedlings are very abundant Other species that attract attention are the cenizo (*Zanthoxylum martinicense* (Lam) DC), which has a trunk covered with stout conical thorns, the cupeys (*Clusia rosea* Jacq and *C Gundlachii* Stahl) with their peculiar semi epiphytic habit, the two llagrumos (*Didymopanax Morototoni* (Aubl) Dcne & Pl and *Cecropia peltata* L), with their large leaves which are brown above and white below, the moralón (*Coccoloba grandifolia* Jacq), with

its very large almost circular leaves, the cojobana (*Piptadenia peregrina* (L.) Benth.), with its peculiar foliage resembling the North America hemlock, isolated individuals of the sierra palm (*Euterpe globosa* Gaernt.), and scattered plants of the two tree ferns (*Cyathea arborea* (L.) J. E. Smith and *Alsophila aquilina* Christ) in places where the cover is not too dense. The straight, tall trunks makes it impossible to study the foliage at a distance. Some of the other trees that are worthy of mention are: the guaraguao (*Guarea Guara* (Jacq.) P. Wilson), the granadillo (*Buchenavia capitata* (Vahl) Eichl.) (Fig. 38), the laurel roseta (*Nectandra patens* (Sw.) Griseb.), the malagueta (*Amomis caryophyllata* (Jacq.) Krug & Urban), the gongolí (*Dendropanax laurifolium* (E. March.) Dcne. & Pl.) the hueso blanco (*Mayepea domingensis* (Lam.) Krug & Urban), the palo de dajao (*Ixora ferrea* (Jacq.) Benth.) the palo de aceite (*Tetragastris balsamifera* (Sw.) Kuntze), the cieniguillo (*Myrcia deflexa* (Poir.) DC.), the cacaillo (*Meliosma obtusifolia* (Bello) Krug & Urban), the maricao (*Byrsonima spicata* (Cav.) DC.), the achiotillo (*Alchornea latifolia* Sw.), the palo blanco (*Drypetes glauca* Vahl) and *Nageia coriacea* (L. C. Rich.) Kuntze). Species of the native Erythrinas may be seen for a long distance in the neighboring forests when in bloom. This forest was originally the habitat of the satinwood or aceitillo (*Simaruba tulae* Urban) which is now almost extinct.

The distribution of these trees shows very little relation to topography, soil or soil moisture, although *Piptadenia peregrina* (L.) Benth. and *Nageia coriacea* (L. C. Rich.) Kuntze are more abundant near the bottoms of the valleys. Nearer the settlements, this valley location is occupied by thickets of the introduced poma rosa (*Jambos Jambos* (L.) Millsp.). In a few clearings and at the edge of the forest, *Miconia prasina* (Sw.) DC. and moral (*Cordia sulcata* DC.), are abundant. The majority of the smaller trees, ranging from 3 to 10 meters in height, are of the common species, but the muñeco (*Dendropanax arboreum* (L.) Dcne. & Pl.) and the jacanillo (*Petesioides pendulum* (Urban) Britton) are regular constituents of this layer.

Most of the numerous shrubs are in reality young trees such as the guaraguadillo (*Guarea ramiflora* Vent.) and the jácana (*Lucuma multiflora* A. DC.) which are very abundant everywhere, and the gongolí (*Dendropanax laurifolium* (E. March.) Dcne. & Pl.), which occur in scattered patches. One of the most common true shrubs is the gesnerad (*Pentaraphia albiflora* Dcne.), which grows in rocky ledges. The rasca garganta (*Parathesis serrulata* (Sw.) Mez) the

galán del monte (*Cestrum laurifolium* L'Her). the icaquillo (*Hirtella rugosa* Pers.) and *Psychotria grandis* Sw. are occasional.

Dense growths of the climbing bamboo-like grass (*Arthrostylidium sarmentosum* Pilger) and to some extent the grasses *Lasiacis divaricata* (L.) Hitchc, and *L. sorghoidea* (Desf.) H. & C. climb over the undergrowth. The high-climbing calabazón (*Philodendron Krebsii* Schott.) is common; gungulén (*Vanilla Eggersii* Rolfe) occurs at wider intervals: and the bejuco de palma or pega palma (*Marcgravia rectiflora* Tr. & Pl.) is also abundant.

The epiphytes are not very abundant; the most conspicuous being the flor de culebra (*Anthurium acaule* (Jacq.) Schott.) which grows in large rosettes on horizontal branches, in crotches of trees, on exposed rocks, stumps and occasionally on the ground. *Hillia parasitica* Jacq. is common, frequently two or three meters in height and with snowy flowers. Small orchids and ferns are common on the rocks, logs, stumps and occasionally on the trunks of living trees. Among the most common of the ferns are *Polypodium latum* (Moore) Sodiro, *P. pectinatum* L., *Elaphoglossum apodum* (Kaulf.) Schott., and *Asplenium cuneatum* Lam. The orchids *Spathiger rigidus* (Jacq.) Small, *Lepanthes selenipetala* Rchb. f. and *Pleurothallis ruscifolia* (Jacq.) R. Br. are also common. The same habitat is shared by *Columnea tulae* Urban and such epiphytes as *Tillandsia tenuifolia* L., and several sterile bromeliads grow on the trees.

The herbaceous ground flora is very scanty or absent. Three species appear to be well adapted to the dense shade and are much more abundant than the others. They are the yerba maravilla (*Ruellia coccinea* (L.) Vahl) and the two delicate grasses *Ichnanthus pallens* (Sw.) Munro and *Pharus glaber* HBK. Occasional plants of the tall achicoria cimarrona (*Tupa robusta* (Graham) A. DC.) and colonies of *Alpinia antillarum* R. & S. grow along the bottoms of the ravines. *Meibomia umbrosa* Britton, *Gesneria pauciflora* Urban and several ferns such as *Blechnum occidentale* L., *Dryopteris Brittonae* Slosson and *Nephrolepis rivularis* (Vahl) Mett. also occur.

There appear to be very few individuals of the smaller, secondary species but this is probably due to their wide intervals rather than their scarcity. Their seed production and migration are certainly sufficient to provide a much larger number of individuals and a more general distribution. The limiting factor is light; each plant from the highest tree to the lowest shrub reduces the amount of light available for those below and makes growth of the smaller plants more precarious. This law applies to their own seedlings and the mortality among the tree seedlings must be exceptionally high. The

epiphytes germinate at higher levels and the vines attain high levels by their rapid growth.

As a result of this reduced light, many secondary species are represented by few individuals except at the edge of the forest and along the trails and roads where there is a maximum amount of light. Among the most characteristic species of shrubs in such places are *Tamonea macrophylla* (D. Don.) Krasser, *T. guianensis* Aubl., *Miconia prasina* (Sw.) DC., *M. laevigata* (L.) DC., *Calycogonium Krugii* Cogn., *Vitex divaricata* Sw., *Piper scabrum* Sw., rama menuda or hoja menuda (*Myrcia splendens* (Sw.) DC.), *Psychotria undata* Jacq., *Erythroxylon rufum* Cav. *Pentaraphia albiflora* Dcne. and *Parathesis serrulata* (Sw.) Mez. Among the herbaceous species we find *Sauvagesia erecta* L., *Nepsera aquatica* (Aubl.) Naud., and *Tontanea herbacea* (Lam.) Standl.). Ferns are abundant and include *Cyathea arborea* (L.) J. E. Smith, *Polypodium Plumula* H. & B., *Dicranopteris bifida* (Willd.) Maxon, *Adiantum tenerum* Sw., *Odontosoria aculeata* (L.) J. E. Smith, and *Hemitelia horrida* (L.) R. Br.

B. The Rain Forest

The tropical rain forest of the Luquillo Mountains is another high-altitude forest and extends to about 600 meters (2,000 ft.), but the original vegetation is intact in only a few places where it has not been subject to selective cuttings to a greater or less degree. The prevailing tree growth is now lower than normal and the best individuals of the most valuable species have been removed. Most tree species of the original growth, with some exceptions such as the tabanuco (*Dacryodes excelsa* Vahl), were scattered and therefore, the sporadic cutting has not resulted in a complete destruction of the forest.

A bird's-eye view of the rain forest shows a solid blanket of green interrupted by the higher cliffs, the small irregularities of the country being concealed. This green blanket presents a mosaic of several shades, varying with the species and the light. From a closer view the crowns are seen to be of various heights, and rounded or spreading. Among the most conspicuous species are the tree ferns (*Cyathea arborea* (L.) J. E. Smith) with their pale green flat tops, the ungainly llagrumo (*Cecropia peltata* L.) which shows flashes of white as its huge leaves are inverted by the wind, the llagrumo macho (*Didymopanax Morototoni* (Aubl.) Dcne. & Pl.) and the occasional Sierra palm (*Euterpe globosa* Gaertn.). Every shade of green, every form of crown and every size of leaf is represented.

As the eye travels up the mountain side, these features blend into a general mosaic, the form and heights of the crowns become less distinct, and the colors merge although the white flashes from the llagrumos are visible from a long distance.

The soil of the rain forest is a red or yellow plastic clay of a variable depth, overlaid by a thin layer of humus and a thicker layer of fallen leaves and stems. The trees stand close together and the general height rarely exceeds 20 meters and the diameter rarely more than 30 centimeters (1 foot), although there are some few trees with diameters 1.5 meters (5 ft.) The general aspect resembles that of the moist tropical forest and the component species are similarly widely scattered. The tabanuco (*Dacryodes excelsa* Vahl.) (Fig. 39) is an exception, in that it grows in small colonies.

The number of tree species is large, each represented by scattered individuals. Mr. W. J. Kramer ranks the valuable species in order of their abundance and importance as follows: the tabanuco (*Dacryodes excelsa* Vahl) (Fig. 39), the sabino (*Magnolia splendens* Urban), the guamá (*Inga laurina* (Sw.) Willd.), the guaraguao (*Guarea Guara* (Jacq.) Wilson), the ácana (*Manilkara nitida* (Sessé & Moc.) Dubard), the roble blanco (*Tabebuia pallida* Miers), the ortegón (*Coccolobis rugosa* Desf.), *Miconia tetrandra* (Sw.) D. Don. and gaimitillo (*Micropholis garcinifolia* Pierre). Other species that were observed by us are the moca (*Andira inermis* HBK.), the granadillo (*Buchenavia capitata* (Vahl) Eichl.) (Fig. 15), the hueso blanco (*Mayepea domingensis* (Lam.) Krug & Urban), the guayabota (*Eugenia Stahlii* (Kiaersk) Krug & Urban), *Coccolobis pirifolia* Desf., *Croton poecilanthus* Urban and *Cedrela odorata* L. The latter is now nearly extinct. Still other species are mentioned by Gifford, including *Ternstroemia luquillensis* (Krug & Urban) Britton, stated by him to reach a diameter of eight feet and probably the largest tree in this respect in the forest; *Myroxylon Schwaneckeanum* Krug & Urban, the caracolillo (*Trichilia pallida* Sw.), the palo de gallina (*Alchorneopsis portoricensis* Urban), the aguacate cimarrón (*Hufelandia pendula* (Sw.) Nees.) the palo de dajao (*Ixora ferrea* (Jacq.) Benth.), the cacaillo (*Sloanea Berteriana* Choisy), the cacao bobo (*Meliosma Herberti* Rolfe), the maricao (*Haemocharis portoricensis* Krug & Urban), as well as several others which from their vernacular names cannot be associated with a species. Four species, llagrumo macho (*Didymopanax Morototoni* (Aubl.) Dcne. & Pl.), the llagrumo proper (*Cecropia peltata* L.), the tree fern (*Cyathea arborea* (L.) J. E. Smith) and *Clibadium erosum* (Sw.) DC., which behave ordinarily as forest weeds, grow in the small clearings and sunny places.

Young trees are abundant under the larger ones and are scattered like their parents. There are very few true shrubs, the most conspicuous being *Palicourea riparia* Benth., which grows to a height of two to four meters. It is most common on the lower levels along the trails where it gets the maximum sunlight. The guao (*Comocladia glabra* (Schultes) Spreng.) and the basquiña (*Pothomorphe peltata* (L.) Miq.) grow well in the deep shade. The camaseys (*Miconia prasina* (Sw). DC., *M. racemosa* (Aubl.) DC. and *Mecranium amygdalinum* (Desr.) C. Wright) colonize open places along the trails. The two shrubby species of galán de monte (*Cestrum macrophyllum* Vent. and *C. laurifolium* L'Her.) and the shrubby rabo de ratón (*Duggena hirsuta* (Jacq.) Britton) are less abundant.

The most conspicuous of the lianas are the bejuco de palma (*Marcgravia rectiflora* Tr. & Pl.) and bejuco de rana (*M. Sintenisii* Urban), the former being the more abundant. They are widely distributed and it is difficult to distinguish them in a sterile condition. They have already been referred to as inhabitants of the moist tropical forests but they are more abundant and larger in the rain forest, reach their maximum in the Sierra palm forests a little above the rain forests and extend to the highest peaks. The bejuco de palma and bejuco de rana are especially interesting because of the peculiar differentiation of the juvenile and adult stages. Seeds of these two species are produced most abundantly in the Sierra palm forests and are widely distributed over that region and the two lower forest They germinate freely on moist rocks, stumps, logs, earthy mossy banks and other places. The juvenile stages are abundant and are characterized by leaves which are closely appressed to the substratum to which the plant clings by means of its aerial roots. The leaves are sessile, ovate-oblong, blunt at the apex, cordate at the base, 1 to 4 centimeters long, crowded or almost overlaping on the short internodes. In this stage it resembles a small climbing aroid more than its own adult stage. Under favorable conditions a lateral branch grows out from the substratum, develops internodes two to three times as long as those of the juvenile plant and leaves which are narrow, oblong, obtuse at the base, and sharply acute or acuminate at the apex. This branch grows over tree trunks 3 to 10 meters in height and forms huge masses 2 or 3 meters in diameter. If a part of this adult plant is broken and falls to the ground, it is very likely to grow and give rise to a juvenile branch like the original juvenile plant.

The second vine in importance is the rasca garganta or calabazón (*Philodendron Krebsii* Schott), a large aroid which climbs to

a height of 10 meters. Several other aroids including the guinda (*Anthurium scandens* (Aubl. Engler) climb but do not attain such large size. True epiphytes are not abundant. *Hillia parasitica* Jacq. trails over the lower tree trunks and is conspicuous by its flower branches and snowy white flowers.

The heavy rainfall and the saturated atmosphere favor the development of many small herbaceous plants which are distributed through the forest and grow in great abundance along the trails where the removal of the shrubs and young trees reduces the competition. The root system of these plants is small and poorly developed; some of them will flourish on moss banks, the rough bark of trees and in rock crevices. Even smooth rocks that are covered with a very thin layer of mosses will be occupied by numerous small herbs. It is very probable that the great majority never come to maturity but the seedling process is continuous and the rocks are never without cover if there is any possible chance for the young plants to gain a root hold. It will be readily seen that under these conditions, it is impossible to distinguish with any degree of certainty the ground plants, rock plants and true epiphytes; in fact the same species may be found behaving in all three ways within a very short distance.

The most abundant of the herbaceous plants belong to the genera *Pilea* and *Peperomia*. Of the latter genus yerba de medio real (*P. rotundifolia* (L.) HBK.) is especially conspicuous, covering tree trunks to a height of a meter or more with a close mantle of small orbicular leaves. *P. emarginella* (Sw.) DC. has this same habit. Among the larger species are: *P. robustior* Urban, *P. alata* R. & P., *P. magnoliaefolia* (Jacq.) A. Dietr. and *P. glabella* (Sw.) A. Dietr. The species of *Pilea* are also plants of deep shade and grow in thin soil or on rocks but do not have the climbing or epiphytic habit of some of the Peperomias. The most common are *P. inaequalis* (Juss.) Wedd., and *P. obtusata* Liebm., but the following are also found: *P. repens* (Sw.) Wedd., *P. Krugii* Urban, *P. Parietaria* (L.) Blume, and *P. semidentata* (Juss.) Wedd.

Associated with the *Pileas* and the *Peperomias* are many other herbaceous plants such as the yerba maravilla (*Ruellia coccinea* (L.) Vahl.), which is abundant and conspicuous because of its scarlet flowers; yerba de San Martín (*Sauvagesia erecta* L.) and the altea (*Nepsera aquatica* (Aubl.) Naud.), which are abundant along the trails; the woodland grass (*Ichnanthus pallens* (Sw.) Munro) and *Stethoma verticillaris* (Nees) Britton. There are also scattered

plants of three small orchids (*Cranichis muscosa* Sw., *Prescottia oligantha* (Sw.) Lindl. and *Physurus plantagineus* (L.) Lindl.), which occur as scattered individuals. The pata de gallina (*Lepidagathis alopecuroidea* (Vahl) R. Br.) and tibey parasitico (*Columnea tulae* Urban) are of occasional occurrence in such places.

There are a few taller species each represented by a few individuals. They are the yerba de plata (*Rolandra fruticosa* (L.) Kuntze) and *Hypitis atrorubens* Poit., which are abundant but far less conspicuous than bijao (*Alpina aromatica* Aubl.) with its tall flowering stems and achicoria cimarrona (*Tupa robusta* (Graham) A. DC.); tangled masses of grasses belonging to the genus *Lasiacis* and the scrambling sedge (*Scleria canescens* Boeckl.), which obstructs the trails with its sharp edged, cutting leaves, are common and frequently abundant.

The ferns are exceptionally luxuriant and range in size from the tree fern (*Cyathea arborea* (L.) J. E. Smith) and *Hemitelia horrida* (L.) R. Br. to the very small ferns a few centimeters in height. Small members of the genus *Polypodium* climb over the tree trunks; mats of the Selaginellas cover the ground and clay banks; and masses of *Dicranopteris bifida* (Willd.) Maxon grow in many places. The others species most likely to attract attention are *Dryopteris reticulata* (L.) Urban, *D. deltoidea* (Sw.) Kuntze, *Polypodium lycopodioides* L., *P. chnoodes* Spreng., *P. loriceum* L., *Polybotrya cervina* (L.) Kaulf., *Nephrolepis rivularis* (Vahl) Mett., *Alsophila borinqueña* Maxon, *Hemitelia horrida* (L.) R. Br., *Hypolepsis repens* (L.) Presl, *Odontosoria aculeata* (L.) J. Smith, *Oleandra articulata* (Sw.) Presl, and *Vittaria filifolia* Fée. *Lycopodium cernuum* L. is common; *L. linifolium* L. grows as an epiphyte, and *Selaginella Krugii* Hieron. forms small mats on the forest floor.

A number of species, some of them of considerable size and others of special interest to botanists are not known outside this rain forest. Some of them have been collected but once and are not well represented in herbaria. Therefore, it is reasonable to suppose that a careful exploration of this region will result in the rediscovery of some of these species and the discovery of additional ones.

3. THE SIERRA PALM FOREST

Climbing above the rain forests or the moist tropical forest and into the Sierra palm forest, we note the first distinctive change in the plant life in the massing of the Sierra palms (*Euterpe globosa* Gaertn.) at and above an elevation of about 600 meters (2,000 ft.). This species, which is represented in the rain forest by scattered

individuals, now becomes the dominant species. Its lowest altitudinal limit is in the Luquillo mountains; in the Central Cordillera, its lowest limit is about 900 meters (3,000 ft.). This variation is probably due to rainfall, atmospheric humidity, wind exposure, temperature and other agencies. The transition from rain forest to palm forest is usually sharp and always far more abrupt than any possible change in the climatic conditions. It appears that the Sierra Palm is better adapted to the higher altitudes than some of the more common species of the rain forests and that its abundant seed production, high germination and close control of its environment prevents any considerable mixing of other species. It is an excellent illustration of ecological dominance, being most abundant and almost the only component of the forest layer, and determining by its environmental control the secondary species associated with it.

The Sierra palm forest forms an almost continuous zone around the Luquillo Mountains at an elevation of about 600 meters (2,000 ft.). A little above this continuous zone, the palms alternate with the mossy forest, the palms occupying the more sheltered ravines. The areas occupied by the Sierra palms may be described as a series of triangles which are united at their bases, their apices extending almost to the summits. On the Cerro de la Punta of the Central Cordillera, near Jayuya, the Sierra palm forest starts at about 900 meters (3,000 ft.) and extends almost to the summit which is about 1,350 meters (4,400 ft.), the highest point in Puerto Rico.

The fact that the palm forests of these two regions differ in altitude by about 300 meters (1,000 ft.) and are very generally located in the sheltered ravines, indicates that they are controlled by meteorological conditions and that the wind exposure is more important than the variations in temperature.

The transitions from the rain to the Sierra palm forest is sharp and well defined, a very complete change taking place within a very few meters. The transition between the palm forest and the mossy forest may be sharp and well defined or broad and poorly defined, depending on the topography of the region. On the eastern or windward slopes it is usually sharp and well defined, while on the slope where the wind exposure is less, it is usually broad and poorly defined, the dominant species of the two forests mingling.

The Sierra palm forest is easily recognized at a considerable distance by the form and size of the leaves and at a still greater distance by the pale green uniform color of the foliage. It is very conspicuous when seen from one of the highest summits which gives a

bird's-eye view of large areas of mountain slopes and shows with great clearness the distribution of the palms in the ravines and in small colonies growing in the shelter of some minor peaks.

The Sierra palm has a straight, erect, cylindrical trunk, which is rarely more than 1.5 decimeter (6 inches) in diameter and 10 to 15 meters (30 to 45 feet) in height, and pinnate leaves, which are 2 to 2.5 meters in length and form a dense shade. The globose fruits are a little more than a centimeter in diameter and are produced in great abundance. Reproduction appears to be retarded by the reduced light but is always sufficient to maintain a pure stand of mature trees. The establishment of other species, either from the rain forest below or the mossy forest above, is very much hindered by fallen leaves which tend to smother the vegetation beneath them Therefore, the palm forest is very open and free from undergrowth (Fig 40). However, there are occasional specimens of the llagrumo (*Cecropia peltata* L.), the tree fern (*Cyathea arborea* (L.) J. E. Smith) and *Clibadium erosum* (Sw.) DC., all of which are common weed trees of the rain forest. There are also a few individuals of cupey (*Clusia rosea* Jacq.), capá cimarrón (*Cordia borinquensis* Urban), hoja minga (*Cananga Blainii* (Griseb.) Britton), achiotillo (*Alchornea latifolia* Sw.), the hueso blanco (*Mayepea domingensis* (Lam.) Krug & Urban), the guaraguao (*Guarea guara* (Jacq.) P. Wilson) and *Miconia tetrandra* (Sw.) D. Don The shrubs are usually very poorly represented. *Psychotria Berteriana* DC. is the most abundant and attains a height of 6 meters, *P. uliginosa* Sw., *P. maleolens* Urban, *Duchartrea Sintenisii* (Urban) Britton and cieneguilla (*Daphnopsis Philippana* Krug & Urban) are smaller in size and less frequent.

The bejuco de palma (*Marcgravia rectiflora* Tr. & Pl.) and the bejuco de rana (*M. Sintenisii* Urban), which have been described as inhabitants of the rain forest, reach their best development in the Sierra palm forest. There are also a few climbing aroids and the climbing bamboo (*Arthrostylidium sarmentosum* Pilger). The species of epiphytic bromeliads that are found in the rain forest are much more abundant in the palm forest. *Hillia parasitica* Jacq. is abundant to an altitude of about 750 meters (2,500 feet). *Peperomia rotundifolia* (L.) HBK. is abundant on the bases of the palm trunks. The number of ferns is reduced but many species of the rain forest persist, including *Struthiopteris exaltata* (Fée) Broadh., *Hymenodium crinitum* (L.) Fée., *Polypodium asplenifolium* L., and *Vittaria remota* Fée, which grow most abundantly along the trails.

The herbaceous plants are reduced both in number of species and number of individuals. The most common and conspicuous is the begonia (*Begonia decandra* Pav.) (Fig. 41) which finds its optimum environment in this forest and grows abundantly wherever the light is sufficient. Clumps of the lengua de vaca (*Anthurium dominicense* Schott) are frequent and conspicuous, and the achicoria cimarrona (*Tupa robusta* (Graham) A. DC.) is common and large. Other species of this forest are *Peperomia alata* R. & P., *Sauvagesia erecta* L., *Crantzia ambigua* (Urban) Britton, *Physurus plantagineus* (L.) Lindl., *Carex polystachya* Sw., *Alsophila quadripinnata* (Gmel.) C. Chr., *Scrophularia minutiflora* Pennel and *Lycopodium cernuum* L.

4. THE MOSSY FOREST

Those portions of the Luquillo Mountains lying above the palm forests are more or less covered by an association known to the foresters as the ridge type and designated by Murphy as the hurricane type. A much better name is mossy forest because of its strong ecological resemblance to similar types of this name in other tropical regions. It occupies the peaks and descends along the more exposed wind-swept ridges (Fig. 42) to an elevation of about 700 meters (2,300 feet). It occupies a corresponding position on the Cordillera Central but descends to very little if any below 1,000 meters (3,300 feet).

In the Luquillo Mountains, this forest occupies the position of the highest rainfall and highest atmospheric humidity. Throughout practically the entire year, the peaks are wrapped for a considerable part of the time in fog or cloud which raises the humidity nearly or quite to the point of atmospheric saturation, resulting in rainfall almost every day and to a very great reduction of sunshine. These clouds collect during the night and cover the mountains at an elevation of 600 meters (2,000 feet). During the day the clouds are formed on the eastern slope and, driven by the winds, they ascend and cross the ridge, enveloping the peaks in cold mist or in drenching rains, and finally moving west where they are evaporated under the tropical sun.

As a result of the high rainfall and atmospheric humidity, the soil of the mossy forest is very generally water-soaked and the plants almost constantly dripping with moisture. The soil is usually thin and in many places the forest floor consists of irregular rocks separated by wet muck and covered with fallen leaves, dead twigs, superficial roots and prostrate stems.

The trade winds which blow almost constantly over the peaks of the Luquillo Mountains are so moist that it is doubtful if they affect the water relations of the plant life seriously but they do have a very pronounced mechanical effect, so that in the most exposed portions the trees are limited in height to about three meters and the tops are kept at a very uniform level.

The temperature is also considerably reduced. Although we have no exact records, it is reasonable to asume that the temperature of the rain forest is about six degrees lower than at sea level, that of the mossy forest 7 to 11 degrees, and that of the peaks of the Cordillera Central as much as 14 degrees.

The four important environmental conditions of the mossy forest appear to be low temperature, high wind exposure, water-soaked soil and an atmosphere of high humidity, frequent fog and mist and heavy rainfall. The wind appears to be the most important factor in differentiating the mossy forest from the palm forest; the former being limited to the summits and to the winds-swept ridges and the latter to the ravines.

The net result of the environmental influences has been the segregation at these high altitudes of a most interesting and distinct flora, few species of which are found in other associations. The few mossy forests of Porto Rico are on the higher elevations and well separated from each other by valleys. This conditions has led to a considerable endemism. The Luquillo Mountains are noted as being the only station for a large number of species; but the Cordillera Central, although less fully explored, also contains several endemic species and is the only known Porto Rican habitat for several other species.

Four species constitute the bulk of the arborescent vegetation: the organillo (*Weinmannia pinnata* L.), the granadillo (*Ocotea spathulata* Mez.), the roble de sierra (*Tabebuia rigida* Urban) and the *Eugenia borinquensis* Britton, none of which occur in the rain forest, except possibly as rare and widely isolated individuals. They are widely distributed at all altitudes of the mossy forest and probably constitute 75 per cent of the dominant species. The species of secondary importance are tortugo prieto (*Ravenia Urbani* Engler), *Calycogonium squamulosum* Cogn., *Miconia pycnoneura* Urban, *M. pachyphylla* Cogn., *M. foveolata* Cogn., *Ceratostemma portoricensis* (Urban) Hoerold, *Petesiodes yunquense* (Urban) Britton, *Thibaudia Krugii* Urban and Hoerold, *Ilex Sintensii* (Urban) Britton, cupeillo (*Clusia Krugiana* Urban), *Grammadenia Sintenisii* (Urban) Mez,

Mecranium amygdalium (Desr.) C. Wright and capá cimarrón or muñeca (*Cordia borinquensis* Urban) and many less numerous species. The bejuco de rana (*Marcgravia sintenisii* Urban) and the bejuco de palma (*M. rectiflora* Tr. and Pl.) are abundant and constitute a striking feature of the vegetation.

At the lower limit of the mossy forest, (Fig. 43) at an elevation of about 700 meters (2,300 feet) these species grow into trees of 8 to 12 meters in height but differ from those of the rain forest in having crooked trunks, more branches and a greater abundance of mosses, *Selaginella* and various epiphytes. With the increase in altitude and greater exposure to wind, the size of the trees is generally reduced. At 900 meters (3,000 feet) the trees on the exposed ridges (Fig. 44) seldom exceed 4 meters in height, while on the wind-swept summit of El Yunque there are large areas of dwarf forest, composed of the same species but not more than two meters in height, and at the very edge of the forest on the rocky promontory, (Fig. 45) *Miconia foveolata* Cogn., *Ilex Sintenisii* (Urban) Britton, *Ceratostemma portoricensis* (Urban) Hoerold, *Eugenia borinquensis* Britton, and roble de sierra (*Tabebuia rigida* Urban) are reduced to not more than one meter in height.

On the lower limits of the mossy forests, the larger size and spreading habit of the trees leads to rather open spacing. On the upper limits the trees are smaller and densely crowded until on the summit (Fig. 46) of the Luquillo peaks, they form dense thickets of crooked nearly interlacing stems, through which vision can seldom penetrate more than 3 to 5 meters. At the lower limit the crowns of the trees are more or less rounded but on the upper limits the exposure to high winds cause the crowns to be level or flattened until at the summit they present an almost perfectly smooth expanse of dense foliage, over which the only contrast is caused by the occasional plants of epiphytic bromeliads and orchids which project above the general level. The close relationship between the wind exposure and the size of the trees is well shown at any ledge of rock; the plants on the lee side growing to a greater height than those on the windward side but not rising above the general level of the wind-drafts from the windward side.

One of the most characteristic features of this forest is the luxuriant growth of mosses and *Selaginella Krugii* Hieron. At the lower limit the trunks of the trees are covered to a height of 3 or 4 meters with a layer of moss and a considerable part of the forest floor is carpeted with mosses (Fig. 47). At the upper limit, the

ground is completely covered with dense mats of *S. Krugii* which climbs the trees to a height of a meter. Above the *S. Krugii* the trunks are completely covered with a dense coat of several species of mosses and hepatics which extends to the smaller twigs and conceals their actual size and the character of their bark so that they all have the same appearance. The leaves are also frequently covered with growths of these same hepatics. Under these conditions, the differences between terrestrial and epiphytic habits are of little importance and most of the secondary species grow indiscriminately on the ground or on the sides of the trees.

The development of the two species of Marcgravia is especially interesting; the juvenile plants grow very abundantly as epiphytes. Some of the mature plants bloom as epiphytes while others are terrestrial and produce long stems two or three centimeters in diameter which scramble through and over the forest at a considerable height. Another noteworthy epiphyte is *Psychotria Grossourdyana* (Baill.) Urban which produces delicate pendant or ascending plants on the dominant trees, resembling an epiphytic ericad in habit quite unlike the commoner species of the genus.

The ferns are very common, the larger ones growing on the ground while the smaller ones grow indiscriminately on the ground or as epiphytes. The common species are *Struthiopteris polypodioides* (Sd.) Trev., *S. Underwoodiana* Broadh., *Cyathea pubescens* Mett., *Diplazium L'Herminieri* Hieron., *Alsophila borinqueña* Maxon, *Polypodium trifurcatum* L., *Lycopodium tenuicaule* Underw. & Lloyd, and various species of *Hymenophyllum* and *Trichomanes*. The lengua de vaca (*Anthurium dominicense* Schott) and a few species of bromeliads are abundant as epiphytes. Delicate plants of *Pilea yunquensis* (Urban) B. & W., *P. Krugii* Urban, *Peperomia hernandifolia* (Vahl) A. Dier. and *Pleurothallis crassipes* Lindl. are common. The grasses (*Arthrostylidium sarmentosum* and *Isachne angustifolia* Nash) grow in the open places. Plants of yerba de maravilla (*Ruellia coccinea* (L.) Vahl.), yerba de San Martín (*Sauvagesia erecta* L.), bijao (*Alpinia antillarum* R. & S.), common begonia (*Begonia decandra* Pav.) and *Stethonia verticillaris* (Nees) Britton, grow along the trail.

The abundant rains prevent the accumulation of soil on the rocky peaks except in the crevices and pockets of the rock, so there are practically no shrubs, although the typical species grow over the edge of the rock, on the lee side (Fig. 48). The grasses and sedges (Fig. 50) are most common and are represented by *Isachne angusti-*

folia Nash, *Arthrostylidium sarmentosum* Pilger, *Machaerina restioides* (Sw.) Vahl, *Rynchospora cyperoides* (Sw.) Mart., *R. Bruneri* Britton and *R. luquillensis* Britton. The small fern *Psilogramme portoricensis* Maxon, the larger fern *Struthiopteris lineata* (Sw.) Broadh and *Cyathea pubescens* Mett. grow in crevices in the rock while *Selaginella portoricensis* A. Br. grows on the sheltered ledges. *Setiscapella subulata* (L.) Barnh. and *S. pusilla* (Vahl) Barnh., common plants of the coastal plain, grow in pockets of wet soil and are excellent illustrations of the wide distribution of seeds. The small orchid *Octadesmia montana* (Sw.) Benth., and the endemic herb *Mikania pachyphylla*[1] Urban are rare on exposed rocks, while *Pitcairnia angustifolia* (Sw.) Redoute is fairly abundant.

The mossy forest association occurs on the higher peaks of the Cordillera Central (Fig. 49) but is very different in many respects from that of the Luquillo Mountains. The influence of the wind is very much reduced, the shrubs are neither bent to the south nor shorn to an even surface but are erect and have rounded crowns. The mosses are reduced to a thin layer on the sheltered trunks or absent and the Selaginellas are completely absent. The bromeliads are few and inconspicuous. The less rigorous environment is shown by the presence of many shrubs of the rain and moist tropical forests and by the more luxuriant development of herbs.

Of the four characteristic trees of the Luquillo mossy forest, only two, the granadillo (*Ocotea spathulata* Mez) and the oreganillo (*Weinmannia pinnata* L.) are present. The roble de sierra (*Tabebuia rigida* Urban) of the former location is replaced by the closely related roble de colorado (*T. Schumanniana* Urban). *Eugenia borinquensis* Britton is lacking. The bejuco de rana (*Marcgravia Sintenisii* Urban) and the bejuco de palma (*M. rectifolia* Tr. & Pl.) are abundant *Miconia pycnoneura* Urban, *Palicourea alpina* (Sw.) DC. *Haenianthus obovatus* Krug & Urban, mata de pez (*Lasianthus Moralesii* (Griseb.) C. Wright), *Ceratostemma portoricensis* (Urban) Hoerold, *Psychotria Grossourdyana* (Baill.) Urban and cupeillo (*Clusia Krugiana* Urban) are present in both regions. Endemism is illustrated by *Persea portoricensis* B. & W., *Ilex Cooki* B. & W., *Didymopanax Gleasoni* B. & W. and possibly by a species of *Xolisma* which appears to be undescribed. The rare shrub *Ilex Riedlaei* Loes. also grows here and this is the lone Porto Rican station for *Torralbasia cuneifolia* (C. Wright) K. & U. Several other species

[1] Careful search during April 1926 disclosed but a single small specimen, possibly the sole remaining plant of the species

of the Luquillo association were not seen but may be present. The plant life of the lower moist tropical forest is represented by *Hillia parasitica* Jacq., cucubano (*Rapanea ferruginea* (R. & P.) Mez), *Urceolaria exotica* Gmel., *Ocotea floribunda* (Sw.) Mez and cupey de altura (*Clusia Gundulachii* Stahl).

The ferns are numerous and include *Odontosoria uncinella* (Kunze) Fée, *O. aculeata* (L.) J. Smith, *Polypodium sectifrons* Kunze, *P. loriceum* L., *Histiopteris incisa* (Thunb.) J. Smith, *Struthiopteris polypodioides* (Sw.) Trev., *S. lineata* (Sw.) Broadh, *Elaphoglossum rigidum* (Aubl.) Urban, *Rhipidopteris peltata* (Sw.) Schott. *Hymenophyllum lineare* Sw., *H. crispum* HBK., *Trichomanes rigidum* Sw., *T. crispum* L., and a species of *Dicranopteris* which is apparently undescribed and endemic to this region, where it forms conspicuous clumps on the peak.

The dominant shrubs are sparser, and the herbaceous plants and under shrubs more abundant than in the Luquillo Mountains. The two grasses of the former region *Isachne angustifolia* Nash and *Arthostylidium sarmentosum* Pilger are common. Other common plants are *Lisianthus laxiflorus* Urban, *Crantzia ambigua* (Urban) Britton, *Pilea yunquensis* (Urban) Britton, *Peperomia tenella* A. Dietr., and *P. hernandifolia* (Vahl) A. Dietr. The orchids are represented by *Amphiglottis secunda* (Jacq.) Britton, *Octadesmia montana* (Sw.) Benth., *Pleurothallis crassipes* Lindl., *Ornithidium coccineum* (Jacq.) Salisb. and *Jacquinella teretifolia* (Sw.) B. & W.

Since each of the preceding five types of forest is largely the result of a definite set of factors such as temperature, rainfall, atmospheric humidity and wind, which are very stable and not subject to variation brought about by the plant life itself, successions between these types is not in progress at the present time and they may all be regarded as climatic climaxes.

VEGETATION OF THE SOUTHERN COASTAL PLAIN AND ADJACENT FOOTHILLS

A. General

The differences between the plant life of the northern and southern portions of Porto Rico are fundamental and apparent to any observing person. The plant life of the north side is easily differentiated into many associations of very different appearance and composition but forms a connected whole and its distribution coincides exactly with the Tertiary coastal plain, the principal environmental factor being the nature of the underlying soil and

rocks, while the climate has only a very broad general effect. The south coastal plain is much smaller in area, the volcanic rocks of the Createceous age coming down almost to the Caribbean sea for about half the length of the Island. The typical plant life covers the Tertiary rocks and extends far up into the central mountain mass. The soil is a subordinate environmental factor, the low rainfall (Fig. 3) being of primary importance. Many species and a few plant associations extend over the various soils regardless of whether they are volcanic, limestone, shale or fluvial outwash.

The abrupt transition from the mesophytic climate and vegetation of the central mountain mass to the xerophytic climate and vegetation of the southern foothills and coastal plain is very evident and can be readily seen in driving from Cayey to Guayama. Leaving the military road at Cayey which is about 400 meters (1,200 feet) above sea level, the road ascends quickly to about 800 meters (2,400 feet), winds along the mountain side and over table lands, gradually descending to within 10 kilometers of Guayama, at which point the elevation is about 650 meters (1,900 feet). From this point to Guayama the descent is very rapid and the transition from mesophytic to xerophytic vegetation equally rapid, there being a very striking change in the general appearance and component species within a distance of about three kilometers. The nature of this change in plant life has been discussed in a preceding part (page 71). The same transition in plant life may be seen on the roads north of Yauco, Villalba and Coamo and south of Adjuntas, sometimes abrupt and sometimes gradual, depending on the location of the roads with reference to the surrounding hills. The presence of the mesophytic species of the mountain in moist spots at low levels and of the xerophytic species of the coast on exposed cliffs at high altitudes indicates that the change in vegetation is not the result of temperature but of moisture.

The transition between the mesophytic and xerophytic regions is less abrupt along the roads which follow the shore line passing through Mayagüez on the west and Humacao on the east. Along the latter road, the fragment of the mountain forest near Humacao, which is in a region of high rainfall, already shows a considerable number of sclerophyllous species. Descending along the southern slope of the Panduras ridge into Maunabo, the transition is completed and from that point west along the coast, the plant life is distinctly xerophytic. At the western end of the Island the typical mesophytic vegetation of the Mayagüez region is continued to the

north slope of the limestone ridge between San Germán and Lajas and almost to Sabana Grande, but a reentrant of xerophytic vegetation occupies the southern slopes of the Maricao mountains to the north.

Geographically, the southern region of Porto Rico lies to the south of an irregular line passing along the southern front of the mountains at an altitude of about 300 to 400 meters (1,000 to 1,500 feet) from the Panduras ridge on the east to a point northwest or north of San Germán, thence returning at a lower level to Sabana Grande, and then west again along the crest of the Lajas range of hills to the ocean south of Cabo Rojo. South of this line, the principal types of land, measured by differences in plant life, rather than by their geology, are the mountains of volcanic origin, the lower shale or limestone hills of the Cretaceous or Tertiary age, and the large outwash plains and valleys of alluvia. Several small tracts of fresh-water marsh, of sand or shingle beach and mangrove swamp are of secondary importance.

Successional processes within the whole area have, in general, been very much retarded and in some environments almost suppressed. The great physiographic processes of erosion, base-leveling and beach formation by which the environments of the north side have been changed are of much less importance on the south side, due to the short rivers, low run-off and a shore line which is protected from the force of the trade winds. The biotic process of soil accumulation and humus formation inland are retarded by the sparseness of the vegetation, due to low rainfall and atmospheric aridity. But the strips of mangrove are constantly building new land along the shore.

Although erosion by water and wind are continuous and the physiographic effects can be observed along the south coast, their activities are here so slow that in most cases there is no evidence of plant movements or of adjustment of boundaries between different associations. A halarch series beginning with the mangrove swamps and culminating in a xerophytic forest, is well defined. Parts of a hydrarch series exist along the lagoons between Guánica and Boquerón and along some of the rivers. An old xerarch series of ancient development has been completed as far as a temporary climax over the arid rocky coastal hills, and a succession from it to the climax forest of the lowlands may be inferred. There are a few isolated illustrations of a xerarch series on beaches and in coastal thickets. The mesarch series of the northern shore is naturally not represented in the arid region, but traces of it may be discovered

in the more nearly mesophytic vegetation of the limestone hills at San Germán. Still another successional trend is exhibited in the foothills of the central mountains mass, where erosion and base-leveling are gradually leading to the replacement of the hillside xerophytes by the climax association of the alluvial plains. Almost every association shows the effect of pasturing or repeated cutting, leading to the development of secondary successions and followed in some cases by the reestablishment of the original vegetation. The general successional relations of the vegetation, together with a few more important secondary associations, are shown diagrammatically in figure 51. Murphy has given a good general account of the forest conditions in this part of the Island and mentions the effect of repeated cutting, burning and pasturing, but without attempt to segregate the various component associations.

B. The Halarch Series of Coastal Swamps and Salt Flats

One of the outstanding topographical features of the south shore are great level tracts of alluvial land, lying adjacent to and but little above the sea. Their origin dates back to an early period of partial submergence, during which the present alluvial lands lay beneath shallow bays of the ocean. The streams from the north carried in large amounts of eroded material and gradually built up deltas. The mangroves slowed the action of both streams and waves and thus causing the suspended materials to settle. With the gradual elevation of the land, the deltas were built farther to the south and the older portions were left above the sea level. The whole process of succession of alluvial soils may still be seen. It involves a pioneer association of mangroves at the edge of the land, a climax association of forest on these older parts of the delta which are removed from the influence of salt water, and one or two intermediate associations of small size.

1 THE MANGROVE ASSOCIATION

We have already indicated that the mangrove swamps of the north shore are limited to the sheltered bays, lagoons and estuaries where they are protected from the action of the waves. Around the eastern end of the Island they come down to the open ocean in many places as is well illustrated at Fajardo Playa; at Ceiba Playa they grow in the water of the open bay, and along the south shore generally they grow in the protected shallow waters with mud bottoms. Comparatively recent changes in the level of the north

coast have resulted in the formation of large land-locked lagoons, coastal swamps and estuaries in which grow hundreds of acres of mangroves. On the south shore the bays are usually deep and surrounded by steep, rocky shores, the river estuaries undeveloped, and the mangroves more widely distributed but not so large nor of such great commercial importance. The best associations are in front of the great alluvial deposits but there are considerable growths on the small islands.

The composition of the mangrove associations of the north and south shores do not differ materially. The four mangrove species are found in both and the secondary species are few in number. The common mangle (*Rhizophora mangle* L.) is the pioneer species and extendes farthest from the shore and into the salt water. It is the first to appear in the open water offshore, where it builds up small islands, which are occupied by it alone for a long time before the incoming of other plants. Mangle blanco (*Laguncularia racemosa* (L.) Gaertn.) and mangle bobo (*Avicennia nitida* Jacq.) follow just back of the common mangle, while mangle botón (*Conocarpus erecta* L.) again forms the interior zone and extends farthest inland and onto the dry land.

Conditions on the land side of the mangrove swamps are in most cases essentially different from those of the north shore. The climate of the north shore is rainy, the supply of ground water abundant, the transitions from salt water to brackish water, and from brackish to fresh water swamps is gradual. The plant life varies primarily with the salinity of the water; and the succession of vegetation is from the mangrove to the Pterocarpus forest or to the cat-tail-sedge association of the hydrarch series. On the south shore, such a transition is exceptional, because of the arid climate, and the succession passes directly from the wet halophyte environment of the mangrove to the xerophytic habitat of the interior. This involves two fundamental changes in the environment, a decrease in the water-content of the soil and a decrease in the amount of salt dissolved in the water.

2 THE BATIS-SESUVIUM ASSOCIATIONS

This association consisting almost entirely of two small herbs is found on a belt of land just back of the mangrove swamps, where there is not sufficient water for the mangroves and where the amount of salt is too great for the growth of the climax forest. This association consists of almost pure growth of barilla (*Batis*

maritima L.), verdolaga rosada or yerba de vidrio (*Sesuvium Portulacastrum* L.) and a few individuals of other species. The soil is usually a yellowish-brown loam, showing that the alluvial deposits have covered the black muck soil which was formed during the preceding growth of mangroves.

These two species have about the same vegetation character; they usually grow prostrate on the ground, although the barilla becomes ascending to as much as 5 decimeters when in dense patches and the verdolaga sometimes scrambles over bushes and stones to the height of nearly a meter; both have thick fleshy leaves adapted to water storage, which is characteristic of other plants in similar environments. They do not grow mixed to any extent but attain their best development in pure patches of as much as an acre in area. The verdolaga appears to prefer the drier soils and frequently grows on land which is somewhat higher than that occupied by the barilla. It also appears to require less salt and extend much farther inland than the barilla and frequently becomes a common secondary species on the shoreward margin of the climax forest

Associations of these two species are conspicuous features of the plant life in many places along the entire south shore. They are easily distinguished from a distance by the pale, yellowish-green color of the barilla and the dark-green or reddish tints of the verdolaga rosada. In the best development of this association, the growth of the dominant is so heavy that secondary species are rarely present. In the thinner patches a few plants of the erect pega pollo (*Commicarpus scandens* (L.) Standley), the prostrate cotorra de la playa (*Heliotropium curassavicum* L.) and the minute red-leaved *Portulaca quadrifida* L. also occur (Fig 52). Isolated depauperated shrubs of mangle botón (*C. erecta* L.) and more rarely of the mangle blanco (*L. racemosa* (L.) Gaertn.) and mangle bobo (*A. nitidia* Jacq.) are sometimes present. The common sea-shore grass matojo de playa (*Sporobolus virginicus* (L.) Kunth) frequently forms a dense sod and indicates the succession to the climax forest.

These two species may also grow in a narrow zone at the edges of mangroves just below the xerophytic forest of the hills of a steep, rocky coast. In these places, the two halophytes may actually grow over patches of the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) but the contact is exceptional (Fig. 53).

Since these species are sun-lovers, it is difficult to understand how this herbaceous association has persisted between the two arborescent associations, the mangroves on the one side and the climax

forest on the other. It may be that they represent a recent development or secondary succession and occupy ground from which the mangroves have been removed for fuel. If so, this association is analogous in its successional relations to the fern (*Acrostichum aureum*) association of the north coast, filling in on relatively dry ground the place taken by the latter on the wet soils. However, we did not observe any indication of its succession by the mangroves.

3 THE SALT FLATS

Near the village of Montalvo, southwest of Guánica, there are extensive areas of alluvial soil almost or entirely destitute of plant life (Fig. 52). These areas are distributed along the shore for a distance of about two kilometers and are sometimes as much as 300 to 400 meters wide. Their elevation is very little above sea level and although the tides do not cover them, the wheels of vehicles crossing them frequently sink a few centimeters into a muddy soil. They are bordered on the shore side by a narrow strip of the Batis-Sesuvium association and terminate in a slightly elevated beach which is occupied by thickets of the xerarch series.

Similar desert tracts are also found to the northeast of Central Aguirre, where there are areas 50 to 100 meters across without a single plant and areas of several acres with a very small amount of vegetation which usually occupies irregular patches. The soil is a yellow-brown silt, apparently a fluvial deposit; it is said to be usually hard and cracked, but at the time of our studies it was moist and smooth after a rain of the preceding night. These areas are bordered on the south by a well-developed mangrove forest of the usual type and separated from it by a narrow tension zone. The small amount of plant life on these areas is limited to depauperated, gnarled, prostrate mangroves (Fig. 54), the most abundant being the mangle botón (*C. erecta* L.); but mangle bobo (*A. nitida* Jacq.) also occurs. Around almost every mangrove, and in some spots between them are rounded patches of almost pure growths of barilla (*Batis maritima* L.) or verdolaga rosada (*Sesuvium Portulacastrum* L.) or sometimes mixtures of the two, in which case the barilla usually occupies the center. On the margin of these flats there is a narrow and interrupted zone of the Batis-Sesuvium association and the tract is bounded by a slightly higher terrain which is occupied by the climax forest.

The development of these two types of salt flats appears to be very much the same and they can doubtless be referred to the same

causes. We believe that they are of artificial origin, caused by the removal of the original mangrove vegetation and the subsequent concentration of the salt at the surface by soil capillarity and surface evaporation, to a point beyond the tolerance of any plants in the local flora.

4. THE CLIMAX FOREST

This forest consists of bucar (*Bucida Buceras* L.) and associated species and originally covered all or practically all of the delta and alluvial deposit back of the mangrove and Batis-Sesuvium associations. The largest single expanse of alluvial plains extends along the shore from Guayama to Ponce, a strip about 70 kilometers long by 1 to 6 kilometers wide. Another large area about 33 kilometers long and about 4 kilometers wide, occupies a depression extending from Yauco to Boquerón between the Lajas range and the coastal hills. Smaller areas border most of the small rivers near their mouths. The soil survey of the Arecibo-Ponce area, records two types of alluvial soils; the Ponce sandy loam and the Ponce loam. They consist of water-washed particles in which the silt and fine sand predominant, are fertile and comprise the best of the cane lands of the southern shore. Almost all of these soils are used for cane growing although the arid climate makes irrigation necessary.

The entire southern range of foothills of the central mountain range is subject to continuous erosion by the numerous small streams which flow down the steep southern slopes. The lower coastal hills are eroded at a lower rate than the higher hills due to the lower rainfall. One result of this erosion is the reduction of some of these lower valleys to base level. These valleys are limited in area and occur only along a few of the larger rivers, such as the Yauco and Guayanilla, where the narrow interrupted belts of alluvium lie along the streams for a few kilometers. It is evident that the vegetational histories of the deltas and valleys are different; the one being derived from the semi-xerophytic vegetation of the foothills and the other from the halarch successional series. The present plant life, however, is essentially uniform throughout and constitutes the climax association of the region.

The original vegetation has been almost completely destroyed, but traces which remain are sufficient to show that the dominant tree of the association was the bucar (*Bucida Buceras* L.). At the present time, this is the most common tree of the pastures and roadsides and along the fence rows through this region. Most of the mature trees now standing are from 10 to 15 meters in height with

ocassional individuals of 25 meters. They branch at a height of 3 or 4 meters and produce broadly spreading crowns, suggesting a growth development after the cutting of the original forest. Large trees of ceiba (*Ceiba pentandra* (L.) Gaertn.) with their huge trunks, relatively small crowns and frequently buttress roots, occur at wider intervals. Other common trees along the roadside and irrigation canals are the moca (*Andira inermis* HBK.), the algarroba (*Hymenaea Courbaril* L.) the *flamboyant* (*Delonix regia* (Bojer) Raf.), the guácima (*Guazuma Guazuma* (L.) Cockerell), the ben (*Moringa Moringa* (L.) Millsp.). The higuero ((*Crescentia Cujete* L.) is abundant in cultivation. The escambrón (*Randia mitis* L.), the basora (*Varronia angustifolia* West), are common shrubs. The grass known as horquetillo (*Chloris radiata* (L.) Sw.) and the shrub *Chamaesyce articulata* (Aubl.) Britton are abundant ground plants. The bucar trees are very generally infested with the nidos de gungulén (*Tillandsia recurvata* L.) which also grows on insulated wires (Fig. 55) in the towns and cities of the south coast between Guayama and Ponce.

The contact of the bucar forest with the Batis-Sesuvium association is usually marked by a zone of the sea shore grass matojo de playa (*Sporobolus virginicus* (L.) Kunth.) which is somewhat halophytic on the south coast. It forms a loose sod adjacent to the Batis-Sesuvium zone and extends back under the trees as scattered colonies and individuals. The barilla (*B. maritima* L.) is rarely found under the trees but mats of verdolaga rosada (*S. portulacastrum* L.) and scattered plants of cotorrera de la playa *Heliotropium curassavicum* L.) and small plants of mangle botón (*C. erecta* L.) are abundant for half a kilometer back into the forest. The seaward limit of the bucar is apparently fixed by the salinity of the soil (Fig. 56.)

Land of this region when cleared and put to pasture very soon reverts into a thorny thicket if not given proper attention (Fig. 57). The most common of these thorny plants are the escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), the palo de burro (*Capparis flexuosa* L.) the flor de mayo (*Parkinsonia aculeata* L.) and other similar thorny or inedible species which rapidly convert the pasture into a jungle of shrubbery. Intermixed with these are such cacti as the sebucan (*Cephalocereus Royeni* (L.) Britton and Rose.), the sebucan or pitajaya (*Leptocereus quadricostatus* (Bello) Britton & Rose.) and the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.).

Another interesting reversion is in progress southwest of Yauco, where the lack of sufficient water for irrigation has lead to the

abandonment of many acres of cane land. Here the ground is first captured by weeds, among which are to be found the margarita (*Bidens pilosa* L.), the yerba de papagallo (*Blechum Blechum* (L.) Millsp.), *Lippia reptans* HBK, and *Wissadula periplocifolia* (L.) Presl). Shrubs follow very quickly; among which are the basora (*Varronia angustifolia* West), the car'aquillo (*Lantana Camara* L.), the aroma casha (*Vachellia Farnesiana* (L.) W. & A.), the escambrón (*Randia mitis* L.), and algodón de seda (*Calotropis procera* (Ait.) R. Br.). These are followed and very soon overtopped by small trees of bucar (*Bucida buceras* L.), the tachuelo (*Pictetia aculeata* (L.) Urban.), the palo de hedionda (*Lonchocarpus latifolius* (Willd.) HBK.) and the calambreña (*Coccolobis venosa* L.). This thicket averages about 5 to 8 meters with many young bucar about 10 meters in height.

The bucar forest not only tends to re-establish itself as the dominant tree after cultivation but also appears as the normal succession of both hydrophytic and xerophytic plant life as will be shown later. There is very little reason to doubt its climax nature, although well developed examples of the association were not seen.

5 SUMMARY OF THE HALARCH SERIES

The mangrove vegetation is widely distributed along the south shore and has been an important factor in the building of the river deltas and flat alluvial areas. It is ecologically the same as the mangrove association of the north coast. The soil back of the mangroves is dry and saline and usually covered with the Batis-Sesuvium association but in places where the salt concentration appears to be unusually high it is completely barren. The climax forest of bucar (*Bucida Buceras* L.) grows well wherever the salinity is not too great and tends to re-establish itself after cultivation and pasturage.

C. The Hydrarch Series of Lagoons and Marshes

The hydrophytic plant life of the south coast is poorly developed. Narrow zones of eneas or cat-tails (*Typha angustifolia* L.) fringe the irrigation canals and occupy small areas of marsh land where the natural drainage is poor, but the only area of any consequence is in the alluvial valleys between Yauco and Boquerón. Our studies were made in this last section and in the small marshy areas between Salinas and Guayama.

The Yauco-Boquerón valley appears originally to have been an

inlet of the sea which extended from Guánica Harbor to Boquerón and isolated the present range of coastal hills from the mainland. This shallow valley was probably filled by a continuous deposition of alluvium which was no doubt aided by an extensive growth of mangroves which still persist in a large swamp at Boquerón The floor of this valley after its elevation above the sea level was not flat but contained many small depressions in which water accumulated from surface drainage of the hills to the north and south and formed lagoons The eastern lagoon, not far from Ensenada, is now dry; the western one, south of Lajas, has a few acres of open water

It is commonly reported by the people living in that section, that the level of the water in these lagoons has varied greatly for many years, depending on the amount of affluent water and on the amount removed by pumps for irrigation Fields which are said to have been under water a few years ago are now (1926) dry and large areas of cane land have been abandoned for want of sufficient water for irrigation Therefore, these lagoons not only show the hydrophytic vegetation of the region, but also the successional stages which lead to the establishment of the climax forest It is reasonable to suppose that a series of years of heavier rainfall, or a change in the source for irrigation water for local agriculture, may cause the lagoons to be filled again and reverse the present sucessional series

South of Lajas, the floor of this great valley appears to be perfectly level, but there is a slight slope to the middle of the lagoon which does not exceed eight decimeters in depth The soil is alluvial but the black color near the lagoon indicates the accumulation of a considerable amount of decayed vegetable matter The lagoon has no definite shore line and its margin cannot be definitely fixed A change of one centimeter in the level of the surface will probably cause a change of a meter in the position of the shore line During the dry season of 1926 the shore line receded about ten meters between February 25 and April 16, the dates of our two visits It is very evident that under these conditions, zones of plant life, such as are usually found on the margins of ponds, cannot be established and maintained

The most conspicuous species is the eneas or cat-tails (*T angustifolia* L.) which grows in almost pure culture and is separated from the shore by a zone of open water Outside the cat-tail zone are small colonies if the tall slender rush-like sedge, junco cimarrón (*Cyperus articulatus* L) and the similar but smaller sedge (*Eleocharis interstincta* (Vahl) R & S.). The lechuguilla de agua (*Pistia*

Stratiotes L.) grows in large floating mats which may be several meters across and are frequently attached to the cat-tails. These mats also contain considerable mixture of the shore grass matojo de playa (*Sporobolus virginicus* (L.) Kunth) and smaller quantities of other plants. This grass sometimes makes a sod so dense that it is used as a nesting place for water birds. The herb *Persicaria punctata* (Ell.) Small, grows as a common secondary species on these mats and the shrub *Sesban Emerus* (Aubl.) Urban is occas asionally found (Fig. 58.)

The open water is crowded with floating plants of *Ceratophyllum demersum* L. and a few unidentified species; also by many isolated plants of lechuguilla de agua (*P. Stratiotes* L.), which are driven from shore to shore by the wind and frequently left stranded by the receding water. In this new habitat they root in the mud and bloom freely. *Lemna perpusilla* Torr. is also common and closely associates with the lechuguilla de agua. The flor de agua (*Castalia ampla* Salisb.) grows and blooms freely in the open water near the shore, and when the water recedes it continues to grow and thrive on the mud flats. Under this latter condition the marsh plants appear quickly and would soon displace them if they were not checked by the rise of water during the next rainy period.

The lagoon is surrounded by a broad, rather indefinite zone of herbaceous plants and a few shrubs but the composition of this zone has undoubtedly been modified by grazing. The most common plants are those which have been avoided by the grazing animals. They are the shrubby *Lippia reptans* HBK, which is abundant, the herbaceous *Persicaria punctata* (Ell.) Small which grows in large patches, *Echinodorus cordifolius* (L.) Griseb which grows in small patches or as isolated individuals and the sedges junco cimarrón (*Cyperus articulatus* L.), *Eleocharis nodulosa* (Roth.), Schultes and *E. mutata* (L.) R. & S. which are quite common. There are also isolated plants of *Pluchea purpurascens* (Sw.) DC. and a species of *Marsilea* forms small mats on the ground.

Outside this last zone of hydrophytes, the herbaceous vegetation consist of grasses and weeds with many scattered trees of bucar (*Bucida Buceras* L.) (Fig. 59) which indicates that the land was originally covered with the climax forest. The abandoned cane lands near the lagoon are reverting to the bucar forest.

The Guánica lagoon which lies several kilometers to the east and not far from salt water at Ensenada, is now (1926) completely dry. Its site is surrounded by abandoned cane lands which have been invaded by weeds and shrubs, the first step towards the re-establish-

ment of the climax forest. The slope of the ground is very slight, as in the Lajas lagoon, and there is no evidence of a deeper depression to mark the site of the old lagoon, but the density of the plant life increases towards a point which we believe was the deepest part or center of the old lagoon. Early collections from this locality include several plants with marked halophytic tendencies and it is probable that the waters of the old lagoon were slightly brackish. This condition is indicated by the present plant life which includes halophytic herbs, such as cotorrera de la playa (*Heliotropium curtassavicum* L.), verdolaga rosada (*Sesuvium Portulacastrum* L.), *Portulaca quadrifida* L. and the shrub *Lippia reptans* HBK., which are still quite abundant. Other shrubs are the basora (*Varronia angustifolia* West), the escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.) and the escambrón blanco (*Volkameria aculeata* L.). The most conspicuous small trees are the flor de mayo (*Parkinsonia aculeata* L.), the mesquite (*Prosopis juliflora* (Sw.) DC.), and the bucar (*Bucida Buceras* L.). The xerophytic character of this environment is shown by two cacti, the sebucan (*Cephalocereus Royeni* (L.) B. & R.) and the duhlago (*Opuntia repens* Bello), which grows in mats. The plant life of the whole area is a sparse thicket in which herbaceous species occupy most of the surface.

There are a number of interesting small areas of hydrophytic plant life just back of the mangrove swamps between Salinas and Guayama. In this region there is a gradual decrease in salinity of the water from the shore inland and the plant life is arranged in four zones (Fig. 60) which are irregular in width and space relations. As the mangrove builds the land farther into the ocean, it is followed by the fresh-water environment and the accumulation of alluvial deposites which transform the marsh into dry land. The four zones of plant life follow in regular order and represent a successional series similar to that of the Caño de Tiburones (page 64) where the initial stages belong to the halarch series and the following associations to the hydrarch series. Hewever, there is this marked difference; the final stage is the xerophytic bucar (*Bucida Buceras* L.) forest.

The first zone is the mangrove swamp. The second zone is an association of the eneas or cat-tails (*T. angustifolia* L.) which grow in patches and are mixed with the shrubby *Pluchea purpurascens* (Sw.) DC. and the viney *Vigna repens* (L.) Kuntze. The soil under the cat-tails is black and shows the effect of decaying vegetable material. Where the cat-tails have been destroyed by pasturing, these mud banks are taken by the herbaceous *Bramia Monnieri* (L.) Drake and the shrubby *Lippia reptans* HBK. The third zone con-

sists of scattered individuals of the shrubby *Pluchea purpurascens* (Sw.) DC., the *Vigna repens* (L.) Kuntze, and dense masses of the sedges *Fimbristylis spadicea* (L.) Vahl, and *Cyperus laevigatus* L. *F. spadicea* is dominant under natural conditions, but when destroyed by grazing animals, *C. laevigatus* becomes abundant and forms a loose sod. The fourth zone occupies the dry ground at the edge of the marsh which was originally occupied by the climax forest. In this fourth zone younger bucar (*B. Buceras* L.) are quite common. The shrubs are represented by aroma casha (*Vachellia Farnesiana* (L.) W. & A.), the basora (*Varronia angustifolia* West), the escambión (*Randia mitis* L.), the viscid mallow (*Bastardia viscosa* (L.) HBK.) and acacia (*Leucaena glauca* (L.) Benth.), which are scattered in the narrow thickets along the fence-rows. The herbaceous plant life is composed mostly of pasture grasses, with occasional mats of *Evolvulus glaber* Spreng. and *Achyranthes polygonoides* (L.) R. Br.

The two hodrophytic areas together present a complete series of associations, including submerged plants, such as *Ceratophyllum demersum*, floating *Pistia stratiotes*, anchored *Castalia ampla*, a marsh association of *Typha angustifolia*, an outer hydrophytic association of *Fimbristylis spadicea* and the climax forest of *Bucida Buceras*. The series may be continuous as in the lagoon at Lajas, or the latter part of it alone may appear and follow the initial stages of the halarch series.

D. The Xerach Series

Subseries a. Beaches and Coastal Thickets.

We have already called attention to the fact that sand dunes are very poorly developed along the south coast of Porto Rico. However, there are many places where the configuration of the shore has favored the building of sand beaches and a few points where small stones have been carried down by the river during periods of flood and built up into small stretches of shingle beach. We have not attempted to analyze the physical conditions accompanying the formation of these two types of beach but it is worthy of note that they may border on the open water of the Caribbean Sea or be separated from the sea by a zone of mangroves or salt flats. In most cases they lie in front of an area of alluvial land, and their plant life shows a transition to the north both geographically and successionally, into the climax forests of *Bucida buceras* L. In other cases, beaches have been formed along rocky limestones or shale shores and the plant life

lies in direct but non-successional contact with the xerophytic forests described below under Subseries b (page 106). Again, as at Boquerón, beaches have been formed in front of tidal marshes, which have been developed into mangrove forests. In all cases, their plant life resembles the corresponding associations of the north shore, but is marked by the presence of many species which are of xerophytic character.

The pioneer plant life which first appears on the upper beach consists of scattered trailing plants of bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.) and the mata de playa (*Canavali maritima* (Aubl.) Thou.), creeping rhizomes with small leafy tufts of the common shore grass matojo de playa (*Sporobolus virginicus* (L.) Kunth), young plants of the shrubby escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), the shrubby aroma casha (*Vachellia Farnesiana* (L.) Wight & Arn.) the flor de todo el año (*Catharanthus roseus* (L.) Don), and a few other species. All of the above species are small and depauperate and are frequently destroyed by wave action. Occasionally small mats of tuna brava (*Opuntia Dillenii* Ker-Gawl.) Haw.) and ohulago (*O. repens* Bello), are developed from joints that are washed down from the thickets above and are left stranded on the upper beach. All of these plants have a temporary existence, are destroyed by waves and replaced by new growths. The plant life of this zone is subject to great variations in density of species from one beach to another.

On the sands or gravels of maritime origin which lie above the upper beach we find the beach thickets. This zone varies in width with the beach deposites and is sometimes as much as 200 meters wide. On its northern or landward margin, the soil changes to one of alluvial deposits and the plant life merges into the climax bucar forest. This narrow strip has but little agricultural value but it gives spaces for homes for many people and the thickets provide a poor pasture for cattle, goats and pigs. As a result of the pasturing, the growth of thorny or otherwise inedible species is favored, and the thickets are largely composed of such plants.

Among the more common species of trees are the guayacán or lignum vitae (*Guaiacum officinale* L.) which attained a height of 10 meters and has a broad, spreading crown with dark-green foliage, the corcho (*Torrubia fragans* (Dum.-Cours.) Standley), and *Pisonia albida* (Heimerl.) Britton which are about equally tall. The cucubano (*Coccolobis laurifolia* Jacq.) is cut repeatedly for fuel at a height of 5 meters. The bucar (*Bucida Buceras* L.) is also quite common. The most abundant shrubs are the thorny species, such

as the aroma casha (*Vachellia Farnesiana* (L.) W. & A.), the jugo (*Rochefortia acanthophora* (DC.) Griseb.), the escambrón (*Randia mitis* L.), the arboreous *Bumelia obovata* (Lam.) A. DC. and *Argythamnia candicans* Sw.; but the most abundant of all is the escambrón colorado (*Pithecellobium Unguis-cati* (Mart.) DC.). The thornless shrubs are the bejuco inglés (*Capparis cynophallophora* L.), the palo de burro (*C. flexuosa* L.), the bejuco de palma (*Trichostigma octandrum* (L.) H. Walt.) and the arborescent prieto (*Tabebuia heterophylla* (DC.) Britton).

One of the conspicuous features of the plant life is the large number of suculent plants such as the sebucan (*Cephalocereus Royeni* (L.) B. & R.) which reaches a height of 5 meters and the sebucan (*Leptocereus quadricostatus* (Bello) B. & R.) which is two or three meters high and widely spreading; the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) which is abundant and grows in mats; the ohulaga (*O. repens* Bello.) which is small, prostrate, and abundant and readily distributed by its fragile joints which are broken off and scattered far and wide by the animals; the maya (*Bromelia pinguin* L.) and the corita (*Agave missionum* Trel.) which is made conspicuous by its tall flower-stalks and clusters or orange-colored flowers.

The vines are represented by the liana uñada (*Batocydia Unguis* (L.) Mart.), the pega palo (*Distictis lactiflora* (Vahl.) D. C.,) the bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.), *Stigmaphyllon lingulatum* (Poir.) Small, and *Banisteria purpurea* L. The shore grass matojo de playa (*Sporobolus virginicus* (L.) Kunth) persists for only a short distance from the shore. The most common species in the true thickets are the pega pollo (*Commicarpus scandens* (L.) Standley), the berenjena de playa (*Solanum persicifolium* Dunal) and the peronia (*Abrus Abrus* (L.) W. F. Wight).

As the sandy beaches become covered to a greater and greater depth by the alluvial deposits from the north, the thicket association is succeeded by the climax bucar (*B. Buceras*) forest. However, this succession may be indefinitely delayed as a result of some of the beaches lying higher than alluvial plains, in which case the fully developed thicket is probably similar to the forest of the limestone coastal hills.

Subseries b. The Coastal Hills

1 GENERAL

The coastal hills of the southern side of Porto Rico fall into two geological series, an older of Cretaceous and a younger of Tertiary

origin The former underlies all the hills between the Ponce limestone and the central mountain mass and consists of tuffs and shales which are of volcanic origin and were deposited under waters of the Cretaceous ocean, and of small beds of limestone which were deposited in clear water during periods of volcanic inactivity The amount of limestone is small but most conspicuous in outcrops in the hills between Juana Díaz and Villalba We regret that the limited time available for this work made it impossible for us to study the flora of this region. The Ponce limestone represents the latter and is deposited mostly near the present shore from Ponce west to Ensenada

The shales and tuffs are calcerous in nature and the hills formed by them are usually weathered into a thin soil full of fragments of rock On the limestones, the formation of a soil by weathering has been very much limited and great surfaces of bare bed-rock are exposed The plant life of the hills has mostly been destroyed or very much modified by cutting, pasturing, and to some extent by agriculture, and persists in relatively good condition only on the very arid and sterile hills of the Ponce formation, especially in the Guánica Insular Forest

Just west of Yauco, there is a small isolated area characterized by serpentine rock and near Maunabo at the eastern end of this district the igneous rock comes down to the water's edge The plant life of these two areas, at this time, does not differ materially from that of the Ponce limestone Therefore, we will first give a description of the plant life of the Ponce formation in the Guánica Insular Forest, where it is preserved in its most nearly natural condition, and later make comparisons with the plant life on the shales, serpentines and tuffs in other parts of the region

2. THE XEROPHYTIC FOREST OF THE PONCE LIMESTONE

The Ponce limestone occupies a narrow crescent shaped area extending from Juana Díaz west and southwest to the shore of Guánica harbor The northering boundary may be marked approximately by a line running about three kilometers north of Ponce, one kilometer south of Peñuelas and Yauco from which point it turns to the southwest The same limestone also occupies the peninsula on the west side of Guánica harbor, with a length of 6 kilometers from east to west It again appears northeast of Cape Rojo, and forms a belt along the shore about 8 kilometers long by 2.5 kilometers wide It comes down to the sea in steep hills and promontories in the last two areas, also between Guánica harbor and Guayanilla

bay, and again in a few places between Guayanilla and Ponce. Its widest development is between Guánica and Guayanilla and west of Ponce.

The general topography of this region is that of rolling hills rising to a height of 150 meters (500 feet) above sea level, usually with long, gentle slopes and few cliffs. These few cliffs and other rock exposures are due to the interpolation of harder strata in the softer limestone. The white or pale yellowish-gray limestone is heavily eroded and pitted into numerous pockets and crevices. Many large blocks of stones are completely separated from the solid, underlying rock, and emit a metallic ring under foot. Ravines and canyons are poorly developed and the drainage is mostly by percolation. A little coarse soil is collected in pits and crevices but large areas of bare flat rock are exposed. Humus has not been formed but in many places the surface is covered by a thin layer of dried leaves and twigs.

The climate of this region is the most arid of any part of Porto Rico and its xerophytic nature is intensified by the general absence of soil so that the surface dries very quickly following every rain. Tree growth is possible only by the penetration of the roots into the deeper fissures in the rock. The scanty growth of taller plants intercepts very little sunlight and shade loving plants are absent. Full exposure to the wind increases transpiration and emphasizes the xerophytic nature of the environment, but the physical effect of the wind is of little importance. One sided trees are not common, even on slopes facing the ocean, but they do occur on the larger capes and promontories, as at La Parguera and south of Ensenada.

The hills of Ponce limestones that are not used for agriculture, are covered with a thin forest and a dense growth of microphyllous shrubs and practically no herbs (Fig. 61). During the dry season the general appearance is that of a low, rather crowded thicket about 2 to 4 meters is height, in which a majority of the shrubs are either leafless or with persistent leaves which are brown and curled by long droughts. Projecting above this growth are many almácigo trees (*Elaphrium simaruba* (L.) Rose) with their wide branches, rounded tops and red, glistening bark, and a less number of bucar (*B. buceras* L.) trees with their dense crowns. There are also a considerable number of bejuco inglés (*Capparis cynophallophora* L.), yaguey (*Ficus laevigata* Vahl), *Amyris elemifera* L. and *Pisonia albida* (Heimerl) Britton. The guayacán or lignum vitae (*Guaiacum officinale* L.) and prieto (*Tabebuia heterophylla* (DC.) Britton) are rare. The almácigo (*E. simaruba* (L.) Rose) is undoubtedly the

the most common tree and forms the ground work of the arborescent vegetation, in which the less abundant trees of other species form isolated spots of green. The sebucan or dildo (*Cephalocereus Royeni* (L.) B. & R.) is very abundant growing to a height of 8 meters and adding to the xerophytic aspect of the plant life.

The shrub layer is made up of a great many species, of which Santa María (*Lantana involucrata* L.), cucubano (*Coccolobis laurifolia* Jacq.), and huevo de gato (*Helicteres jamaicensis* Jacq.) appear to be the most abundant. Other common species are bertonica afelfada (*Moluchia tomentosa* (L.) Britton), adormida (*Croton rigidus* (Muell. Arg.) Britton) fire bush (*C. lucidus* L.) cuero de sapo (*Erostema caribaeum* (Jacq.) R. & S.), basora (*Varronia angustifolia* West.), escambrón colorado (*Pithecellobium unguis-cati* (L.) Mart.), cotorra (*Ricinella ricinella* (L.) Britton), granadillo (*Eugenia lingustrina* (Sw.) Willd.) arguilo (*E. burifolia* (Sw.) Willd.), jibo (*Schaefferia frutescens* Jacq.), chicharrón (*Reynosia uncinata* Urban), bálsamo (*Citharexylum fruticosum* L.), alelí cimarrón (*Plumiera alba* L.), bariaco (*Krugiodendron ferreum* (Vahl.) Urban), coscorrán (*Elaeodendrum xylocarpum* (Vent.) DC.), guao (*Comocladia dodonaea* (L.) Urban), barbasco (*Canella winterana* (L.) Gaertn.), *Salvia sessiliflora* (Sw.) Willd., *Hypelate trifoliata* Sw., *Savyda dodecandra* Jacq. *Adelia Bernardia* L., *Jacquinia Berterii* Spreng., and *Tournefortia microphylla* Bert. Most of these shrubs are without leaves during the dry season, but when the leaves are present they are usually small, rounded, leathery and dark green. Leafy plants stand is sharp contrast with the prevailing brown or gray color which is characteristic of most of this vegetation.

The cacti are represented by large specimens of the two sebucans or dildos (*Cephalocereus Royeni* (L.) B. & R. and *Leptocereus quadricostatus* (Bello) B. & R.) which are abundant and 3 or 4 meters in height; also by great mats of tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) which are less conspicuous but equally abundant and by ohulago (*Opuntia repens* Bello) which covers some places. The less common plants are pitajaya (*Hylocereus trigonus* (Haw.) Safford) which hang from the larger trees and many colonies of the conspicuous melón de costa (*Cactus intortus* Mill.) attaining height of 6 decimeters. The corita (*Agave missionum* Trel.) with its flowering stems about 6 meters in height is one of the striking features of the landscape.

The vines are represented by a few individuals, such as the bejuco de costillo (*Serjania polyphylla* (L.) Radlk.) which appears to be the most abundant, the dunguey (*Smilax coriacea* Spreng.)

and the gungulén (*Vanilla Eggersii* Rolfe). The epiphytic nidos de gungulén (*Tillandsia recurvata* L.) is very abundant and green bunches of pata de gallina (*Phoradendron chrysocarpum* Krug & Urban) are occasional. There are very few herbaceous plants during the dry season, but small plants of *Portulaca halimoides* L. and yerba de pollo (*P. quadrifida* L.) can be found growing in small pockets in the rocks. There are also a few grass plants (*Uniola virgata* (Poir) Griseb) and isolated plants and small colonies of *Zamia portoricensis* Urban are scattered over hill tops.

Our study of this region was made in April when the only blooming plant was the single specimen of the purple-flowered leguminous shrub, the retama (*Corynella pauciflora* DC.). It appears that the many plants which were leafless at the time of our visit, put forth their new leaves and that many herbs become more or less prominent during periods of rainy weather.

The plant life which we have just described occupies the hill tops and upper slopes. About halfway down the southern slope towards the ocean, and at an altitude of about 80 meters (250 feet) lies a narrow zone characterized by a very remarkable development of epiphytes. The shrub flora is less developed but represented by the same species as are found on the hill tops. The bucar (*B. buceras* L.), the almácigo (*E. simaruba* (L.) Rose), the bejuco inglés (*Capparis cynophallophora* L.), and the tea (*Amyris elemifera* L.) are the most common trees. Many of the larger bucar trees branch from the base and in some cases the large basal limbs lie on the ground. The alelí cimarron (*Plumeria alba* L.) attains a height of 6 to 8 meters and the freely-branching cupey de altura (*Clusia Gundlachii* Stahl.) attains a height of 5 meters and forms a thicket of tough, inflexible stems and twigs. The same six species of cacti previously referred to are present and larger. The melón de costa (*Cactus intortus* Mill.) is represented by hundreds of plants, mats of tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.) grow several meters in diameter and 2 meters in height, while the sebucan (*Cephalocereus Royeni* (L.) Britton & Rose) attain a height of 10 meters. All trees and the larger cacti are drapped with barbas de uear (*Dendropogon usneoides* (L.) Raf.) forming festoons a meter or more in length and growing so luxuriantly as to almost conceal the branches and in some cases they appear to injure the plants on which they grow. In fact, this growth of barbas de uear is so dense that visibility seldom extends beyond 10 meters in any direction and under some of the low branching bucar trees is even less. The nidos de gungulén (*Tillandsia recurvata* L.) and a sterile bro-

meliad are very abundant on all trees. The larger cacti, and the epiphytic cactus pitajaya (*Hylocereus trigonus* (Haw.) Safford) are common, while masses of fallen bromeliads almost cover the ground in some places. Even the orchid (*Encyclia papilionacea* (Vahl) Schechter) is epiphytic on the cacti. We have no theories as to the possible environment conditions determining the location of this remarkable zone of epiphytes, except that it may possibly be due to atmospheric conditions. The arborescent flora is the same as that found at higher levels and the smaller number of shrubs may be due to the dense shade cast by the trees and their loads of epiphytes. The belt is said to extend along the hillside at the same level for a considerable distance, although its width probably does not exceed 10 meters in altitude.

Below this belt of epiphytes, the plant life has the same specific composition and general appearance as on the hill tops. The guao (*Comocladia Dodonaea* (L.) Urban) becomes very common, while other common species are manto or maravedí (*Rhacoma crossopetalum* L.), lirio (*Strumpfia maritima* Jacq.) and *Krameria Ixina* L. These and other species common to this locality come down almost to sea level and are separated from the water by a very narrow rocky beach, full of rocky fragments. The common plants of this beach are barilla (*Batis maritima* L.), bejuco de playa (*Ipomoea Pes-caprae* (L.) Roth.), and mangle blanco (*Laguncularia racemosa* (L.) Gaertn.) which grow adjacent to the bucar, sebucan and guao. There is no successional relation between them, and will not be unless a future change in elevation brings about a readjustment of the boundary.

In most other places, the plant life of the Ponce limestone has been partly destroyed by cutting and consists almost entirely of shrubs. Good examples of this shrubby growth may be seen along the shore road from Ponce to Guayanilla. Additional species observed here and which no doubt grow in parts of the Guánica forest are *Catesbaea parviflora*, Sw., lechecillo (*Groton discolor* Willd.), *Stenostomum acutatum* DC., *Bumelia Krugii* Pierre, *Turnera diffusa* Wild., and *Osmia sinuata* (Lam.) B. & W., the viney *Stigmaphyllon lingulatum* (Poir) Small., the orchid (*Tetramicra elegans* (Hamilt.) Cogn.) and the grass *Uniola virgata* (Poir) Griseb. On the hills south of Ensenada, the corita (*Agave missionum* Trel,) is very abundant.

3 THE VEGETATION OF THE SHALE HILLS

These shale hills form a belt about 2 kilometers wide extending from near Ensenada at the east to the coast south of Boquerón and

have an average height of about 150 meters (500 feet). The sides are steep or gently sloping, with little exposed bedrock. The soil is thin, hard, coarse in textures and mixed with numerous fragments of rock. On a few of them the original plant life is in fairly good condition and essentially the same as in the Guánica Forest but in most cases trees and the shrubs have been removed in order to make pasture.

The trees on these hills are rarely more than 10 or 15 meters in height (Fig. 62). The bucar (*Bucida buceras* L.) is much more abundant than any other species. Others that should be mentioned as common are retama (*Trichilia hirta* L.), carubia (*Xanthoxylum monophyllum* (Lam.) P. Wilson), guácima (*Guazuma guazuma* (L.) Cockerell), guayacán or lignum vitae (*Guaiacum officinale* L.), hediondilla (*Leucaena glauca* (L.) Benth.), tea (*Amyris elemifera* L.) and cucubano *Coccolobis laurifolia* Jacq.). The abundant growth of shrubs includes cotorra (*Rivinella rivinella* (L.) Britton), guao (*Comocladia dodonaea* (L.) Urban), algodón de seda (*Calotropis procera* (Ait.) R. Br.), palo de vaca (*Bourreria succulenta* Jacq.), espejuelo (*Sarcomphalus reticulatus* (Vahl) Urban), huevo de gato (*Helicteres jamaicensis* Jacq.), escambrón colorado (*Pithecellobium Unguis-cati* L.), palo de burro (*Capparis coccolobifolia* Mart.) roseta (*Machaonia portoricensis* Baill.) yaiti (*Gymnanthes lucida* Sw.), jiba (*Schaefferia frutescens* Jacq.) *Jacquinia Berterii* Spreng., *Rondeletia pilosa* Sw., *Thouinia portoricensis* (Radlk.) Britton, and *Stenostomum lucidum* (Sw.) Gaertn.

There are very few cacti under the shade of the shrubs or forests, probably due to lack of light, but they are abundant on the adjacent hills, where the trees and shrubs have been removed. The melón de costa (*Cactus intortus* Mill.) grows in colonies that are sometimes conspicuous at a distance and the ohulaga (*Opuntia repens* Bello) becomes a serious pest in the pastures. The larger species of *Cephalocereus* and *Leptocereus* are rare. The nidos de gungulén (*Tillandsia recurvata* L.) is abundant everywhere and the barbas de uear (*Dendropogon usneoides* (L.) Raf.) is well developed on the bucar trees (Fig. 63) in the sheltered valleys. Herbaceous species are rare in the thickets.

Plant life of the type just described occupies all of the north side of the coastal range of hills as seen from the road between Ensenada and Lajas. A few of the hillsides still have a few forest trees, more have been reduced to shrubby thickets and may have been cleared and replaced by pasture with a few scattered bucar trees. The same plant life also occupies the uncultivated hills of

the Lajas range from Boquerón east almost to Yauco. Over this entire area, there is a dense population and much of the land is used for agriculture, while the remainder has been cut over repeatedly for fuel. As a result, the arborescent growth is represented by a few small trees while many introduced weeds have come in. On one of these hills south of Lajas, the most common shrubby species are: cafeíllo (*Casearia guianensis* (Aubl.) Urban) which grows two to four meters in height, cariaquillo (*Lantana camara* L.) and the escambrón (*Randia mitis* L.). The trees are small and include the following species: almácigo (*Elaphrium simaruba* (L.) Rose), cupey (*Clusia rosea* Jacq.), jaguey (*Ficus laevigata* Vahl.), cenizo (*Zanthoxylum caribaeum* Lam,) and *Z. monophyllum* (Lam.) P. Vilson. Other common shrubs are basora (*Varronia angustifolia* West.), caracolillo (*Casearia decandra* Jacq.), galán del monte (*Cestrum laurifolium* L'Her.(acacia pálada (*Leucaena glauca* (L.) Benth.), higuillo (*Piper aduncum* L.), guava blanca (*Cupania Americana* L.) and *Psychotria undata* Jacq. The desmanto (*Acuan virgatum* (L.) Medic.), a thorny, scrambling plant is common. There are no cacti. The influence of man on the plant life is shown by the irregularity in size of the trees and shrubs, the frequent coppice growths and the many herbaceous weeds.

Lajas stands at the northern boundary of the xerophytic region and several plants of mesophytic tendences appear on the hills in the vicinity. The presence of the cupey (*C. rosea*) and the absence of cacti is significant of this transition in the plant life near this place.

On a hill a few kilometers west of Yauco, geologically similar to the preceding, but away from the proximity of a mesophytic environment, the arborescent species include the almácigo (*Elaphrium simaruba* (L.) Rose), the palo anastacia (*Trichilia hirta* L.), and only a few bucar (*B. buceras*) trees which are always the first to be removed from these hills. The most common shrubs are cariaquillo (*Lantana Camara* L.), escambrón colorado (*Pithecellobium unguis-cati* (L.) Mart.). Other common shrubs are tachuelo (*Pictetia aculeata* (Vahl.) Urban), cuero de sapo (*Exostema caribaeum* (Jacq.) R. & S.), ceboruquillo (*Thyana striata* (Radlk.) Britton). jiba (*Schaefferia frutescens* Jacq.), adormida (*Croton rigidus* (Muell Arg.) Britton), *Stenostomum lucidum* (Sw.) Gaertn. f., *Guettarda elliptica* Sw. and *Forestiera segregata* (Jacq.) Krug and Urban. The vines such as bejuco de costilla (*Serjania polyphylla* (L.) Radlk.), liana uñada (*Batocydia unguis* (L.) Mart.), and desmanto (*Acuan virgatum* (L.) Medic.) are well distributed. The nidos

de gungulén (*Tillandsia recurvatum* L.) is abundant; ***Zamia portoricensis*** Urban and sebucan *Cephalocereus* ***Royeni*** (L.) B. & R. are present. This hill has not been pastured but the best trees have been removed. The shrubs show a great similarity to those of the Ponce limestone. (Figs. 64, 65.)

4. VEGETATION OF THE SERPENTINE HILLS

The Geological Survey of the Ponce district mentions two small serpentine outcrops: one in the coastal range of hills west of La Parguera and one a few kilometers west of Yauco. Our studies were confined to the latter. The serpentine at this point underlies a low, rounded hill which was originally covered with forest, but which has been cut over repeatedly and used for pasture with the usual effects on the plant life. The few remaining trees are mostly bucar (*Bucida Buceras* L.) and almácigo (*Elaphrium Simaruba* (L.) Rose). The most abundant vegetation at this time consists of thickets of cacti and shrubs; and almost every species found here was also found on the Ponce limestones or shales of the vicinity. The most common cacti are the two sebucans (*Cephalocereus Royeni* (L.) B. & R. and *Leptocereus quadricostatus* (Bello) B. & R. (Fig. 64), the tuna brava (*Opuntia Dillenii* (Ker-Gawl.) Haw.), the ohulaga (***O. repens*** Bello) and the melón de costa (*Cactus intortus* Mill.) Fig. 65). Other plants with well developed water storage structures are the corita (*Agave missionum* Trel.), the alelí cimarrón (*Plumiera alba* L.), the maya (*Bromelia pinguin* L.) and the shrubby *Pedilanthus angustifolius* Poir. The most common shrubs are the roble de colorado (*Tabebuia haemantha* (Bert.) DC.) escambrón colorado (*Pithecellobium Unguis-cati* (L.) Mart.), guao (*Comocladia Dodonaea* (L.) Urban), adormida (*Croton rigidus* (Muell. Arg.) Britton, roseta (*Machaonia portoricensis* Baill.), granadilla (*Eugenia ligustrina* Willd.), guayabacoa (*Rheedia acuminata* (Spreng.) Tr. & Pl.) and *Jacquinia Berterii* Spreng. The vines and epiphytes are represented by pega palo (*Distictis lactiflora* (Vahl.) DC.), pitajaya (*Hylocereus trigonus* (Haw.) Safford) and ***Banisteria purpurea*** L., ***Osmia sinuata*** (Lam.) B. & W. None of these have been noted by Britton and Wilson as characteristic of the serpentine rocks and we are of the opinion that serpentine is of little or no importance as an environmental factor in this part of the Island.

5. THE VEGETATION OF THE CAPE MALA PASCUA

We did not examine the plant life of the outcrops of the Yabucoa Point, respectively south and east of Maunabo at the southeast-

ern corner of the Island, but the Cretaceous tufts which appear in the same region bear the usual xerophytic vegetation, with some differences in specific composition due to distance.

The promontory of Cape Mala Pascua (Fig 66) descends abruptly to the sea from a height of nearly 200 meters (600 feet). Most of the forest has been removed but the remaining fragments indicate that the dominant trees were probably bucar (*Bucida buceras* L), guácima (*Guazuma guazuma* (L) Cockerell) palo anastacia (*Trichilia hirta* L), jaguey (*Ficus laevigata* Vahl), corcho (*Pisonia subcordata* Sw), carubio (*Zanthoxylum monophyllum* (Lam) P Wilson), ceiba (*Ceiba pentandra* (L) Gaertn.) The most common shrubs are cafeíllo (*Casearia guianensis* (Aubl) Urban) which grows in almost pure stands; cotorra (*Ricinella ricinella* (L) Britton) which grows in dense masses and to a height of 6 meters, escambron (*Randia mitis* L) which grows to a height of 2 meters and *Psychotria pinularis* Seese & Moe which grows in matted thickets to a height of 1 5 meters and shows the effects of the wind Acacia palada (*Leucaena glauca* (L) Benth grows abundantly along roads Other shrubs worthy of mention are prieta (*Tabebuia heterophylla* (DC) Britton), bejuco de palma (*Trichostigma octandum* (L) H Walt), bálsamo (*Citharexylum fructuosum* L), palo de burro (*Capparis flexuosa* L), roble guayo (*Bourreria succulenta* Jacq) and bariaco (*Krugiodendron ferreum* (Vahl) Urban) All of the above have been mentioned previously in connection with other developments of this same association and are sufficient to show the general uniformity of this xerophytic type across the full length of the southern shore An interesting feature of this promontory is the presence of San Bartolomone (*Sebesten rickseckeri* (Mills) Britton) which is 2 or 3 meters in height and has showy red flowers and very thick rough leaves, and also the shrubby *Malphighia Shaferi* B & W with leaves which are covered on the lower surface with appressed easily detached stinging hairs The former has been known only from Vieques, Culebra, St. Thomas and Tortola, the latter has theretore been considered endemic to Vieques

Intertwined with the above shrubs we find many vines such as the true zarza (*Acacia riparia* HBK) reaching a diameter of 5 centimeters, the smaller bejuco de costilla (*Serjania polyphylla* (L.) Radlk), *Banisteria purpurea* L., *Stigmaphyllon lingulatum* (Poir) Small, and *Gouania lupuloides* (L.) Urban. Cattle avoid the steeper parts of the hillsides which permits the growth of many shrubs and herbs such as *Justicia periplocifolia* Jacq., *J. sessilia* Jacq. *Hyptis*

pectinata (L.) Poir), and *Dolicholus reticulatus* (Sw.) Millsp. The presence of a single plant of cupey (*Clusia rosea* Jacq.) indicates the proximity of the more mesophytic conditions.

6 GENERAL RELATIONS AND SUCCESSIONS

The preceding description is based on a study of seven separate areas of xerophytic forest or thicket, extending over more than a hundred kilometers of space. In five of these the plant life has been very much modified by man, in one there is somewhat less modification and in one, the Guánica Insular Forest, it is in practically natural conditions. Therefore, it cannot be expected that the flora of the seven areas should show a great degree of homogenity. The number of species noted by us as reasonably common and of ecological importance in these areas ranges from 18 on the Ponce limestone near Tallaboa east of Guayanilla Harbor to 63 in the Guánica Insular Forest. The species noted from a single area only range from 4 on the shale hill to 34 on the promontory south of Maunabo. They constitute 59 per cent of the whole at Maunabo, due to isolation and the proximity of the mesophytic forest of the mountains, and in the other six areas vary from 17 to 30 per cent. The other species of each area, vary from 13 to 44 in number, appear also in other places, and the community coefficient between any two areas averages 11 per cent. It is lowest between the comparatively close areas of La Parguera and Tallaboa and greatest between Guánica Insular Forest and the serpentine hill at Yauco, in which the underlying rock is quite different. The coefficients between the isolated area at Maunabo and the other six average 9 per cent, showing that the large number of peculiar species in that isolated locality is after all of little geographic significance. We are, therefore, led to the conclusion that under natural conditions all of these rocky hills of the southern coast were populated by essentially the same type of vegetation, that the discrepancies which then occurred were caused primarily by geographic isolation and by proximity to or distance from a more mesophytic environment, and that the present differences are caused by clearing and pasturing.

The xerophytic character of the environment is clearly shown by the prevailing form and habit of the plants. Tropophilous species are abundant dropping their leaves during the dry season and producing a new crop with the beginning of the rains. The habit is well illustrated by many of the shrubs and especially by a great number of characteristic trees of almácigo (*Elaphrium simaruba* (L.) Rose). The low rainfall, the irregularity of the rains and the

low-water-holding capacity the stony soil probably explains the relatively small number of water-storage plants which are well illustrated by the cacti, corita (*Agave missionum* Trel.), bruja (*Bryophyllum pinnatum* (Lam.) Kurz) and *Portulaca quadrifida* L. The majority of the species are well adapted to the arid conditions by their small, thick, leathery leaves. An anatomical study of such species would probably show many interesting devices to reduce the loss of water.

The dominant trees arranged in order of their importance are the almácigo (*Elaphrium Simaruba* (L.) Rose), bucar (*Bucida buceras* L.), tea (*Amyris elemifera* L.) and *Pisonia albida* (Heimerl.) Britton. Other common species of this association are the roble guayo (*Bourreria succulenta* Jacq.), the sebucan (*Cephalocereus Royeni* (L.) B. & R.), the cucubano (*Coccolobis laurifolia* Jacq.), bálsamo (*Citharexylum fruticosum* L.), guayacán (*Guiacum officinale* L.), espejuelo (*Krugiodendron ferreum* (Vahl.) Urban), cotorra (*Ricinella ricinella* (L.) Britton, jiba (*Schaefferia frutescens* Jacq.), palo anastacia (*Trichilia hirta* L.) and carubia (*Zanthoxylum monophyllum* (Lam.) P. Wilson.

The association is now in a state of temporary climax and no successional processes are actively in progress. Erosion is proceeding at a very slow rate. Unless other agencies supervene the hills will be reduced to a base level and the present plant life followed by the climax bucar (*B. buceras* L.) forest of the lowlands.

7 THE SEMI MESOPHYTIC VEGETATION OF THE SAN GERMAN LIMESTONE

We have already called attention to the region of copious rainfall which extends south of Mayagüez along the west coast of the Island, so that a part of the coastal plain from Cabo Rojo east almost to Sabana Grande is characterized by a mesophytic vegetation, and various species have been able to establish themselves here and there among the xerophytes of the neighboring hills. Almost all of the mesophytic area is now under cultivation and the natural plant life is chiefly confined to narrow canyons and steeper hillsides. Even these hillsides are very generally used for pasture and the best illustration of the normal plant life occurs on some of the hills of San Germán limestone between the towns of San Germán and Lajas. These hills are unusually steep with many exposed ledges and vertical cliffs. The limestone is white in color, broken into numerous fragments, and very much eroded into pits, sharp points and knife-like edges. Its general appearance is very similar to the mogoto or hay-stack hills of the north coast. The soil, above the talus slopes

at the base, is restricted to thin deposites in the crevices and on the ledges.

The plant life is similar in its general features, to that of the xerophytic hills of tuffs and shales in the same vicinity and already described (Fig. 68). The almácigo (*Elaphrium Simaruba* (L.) Rose), is the most common tree and grows in abundance over the upper slopes and tops of the hills. It is usually heavily infested with nidos de gungulén (*Tillandsia recurvata* L.). The bucar (*Bucida buceras* L.) is second in abundance. Beneath these trees is a loose thicket of various xerophytic shrubs, including the jiba (*Schaefferia frutescens* Jacq.), palo de burro (*Capparis flexuosa* L.), bariaco (*Krugiodendron ferreum* (Vahl), Urban), cotorra (*Ruenella Ruenella* (L.) Britton), cucubano (*Coccolobis laurifolia* Jacq.), cupey de altura (*Clusia Gundlachii* Stahl.), and *Zamia portoricensis* Urban (Fig. 69).

The effects of the mesophytic climate is shown by the presence of certain other species which are common on the mogotes or haystack hills of the north shore some of which were not noted by us in any other locality on the south side of the Island. The most conspicuous are the llume palm (*Gaussia attenuata* (Cook) Beccari which is common on the tops of the hills and in the thinner soils. Other species of this category are cupey (*Clusia rosea* Jacq.), gungulén (*Vanilla Eggersii* Rolfe), flor de culebra (*Anthurium acaule* (Jacq.) Schott.) the shrub (*Curcas hernandifolius* (Vent.) Britton) and the pitajaya (*Hylocereus trigonus* (Haw.) Safford).

E. The Vegetation of the Lower Mountain Slopes

The abrupt transition between the mesophytic plant life of the central mountain region and the semi-xerophytic plant life of the lower slopes of the south side have already been mentioned (page 92). A short distance south of the water shed which extends the length of the Island, the whole aspect of the country changes. Along the upper part of this water shed, the plant life is primarily forest, either in fact or in superficial appearance, while below, it consists of grass-covered hillsides (Fig. 66) with many scattered trees and narrow strips of shrubs and trees along the bottoms of the valleys. The hills have sweeping, rounded contours and are separated by narrow valleys of the steep gradient. The plant life of these hills is brown during the dry season, except for the mango trees which retain their dark green color. At this season the general aspect of the landscape is very similar to the summer appearance of parts of

California The charm of the broad panoramas is enhanced by the open park-like country, and the views from any of the many highways are among the finest in Porto Rico

From a botanical standpoint, the country is not so satisfactory. Originally this region was probably covered by relatively thin, open forest, which has been completely destroyed, so that neither characteristic species nor associational boundaries can be determined with accuracy Most of the land is in pasture with some few small tracts under cultivation The original native vegetation is restricted to the roadsides and to narrow zones of trees and shrubs which spring up along the beds of the streams and arroyos In a few places, these zones broaden out into thickets or small groves, but they are always composed of second-growth trees of small size and cannot be be considered fair examples of the original normal plant life of the Island

Along the Cayey–Guayama road, the transition from mesophytic to a xerophytic plant life is mostly accomplished within three or four meters The zone of transition lies chiefly between altitudes of 300 and 500 meters (1,000 and 1,600 feet) and xerophytic plant life is fully established below 300 meters (1 000 feet) The character of this transition, and its relation to ridges and canyons, have been discussed in our treatment of the mesophytic forest of the mountain (page 92) and needs no repetition

The most common trees of this region are those which have been conserved for their fruits, for shade, for living fence posts or for other uses when mature They are the bucar (*Bucida buceras* L), guácima (*Guazuma guazuma* (L) Cockerell), almácigo (*Elaphrium simaruba* (L) Rose), corazon (*Annona reticulata* L), higuero (*Crescentia cujete* L) ceiba petandra (L) Gaertn), and the mango (*Mangifera indica* L) Other species of secondary abundance are the algarroba (*Hymenaea Courbaril* L), acacia pálida (*Leucaena glauca* (L) Benth), Campeche or logwood (*Haematoxylon campechianum* L), palo anastacia (*Trichilia hirta* L), flor de mayo (*Parkinsonia aculeata* L), flamboyant blanco (*Bauhinia monandra* Kurz), moca (*Andira inermis* HBK), calambreña (*Coccolobis venosa* L) and caimito de perro (*Chrysophyllum pauciflorum* Lam.). The rare endemic tree known locally as palo de tortuga (*Phlebotaenia Cowellii* Britton) is more abundant in this region than elesewhere in Porto Rico

A large number of shrubs grow along the roadside, the most abundant being the basora (*Varronia angustifolia* West), maíz pe-

lado (*Comocladia Dodonaca* (L.) Urban), cotorra (*Ricinella ricinella* (L.) Britton), bálsamo (*Cithrexylum fruticosum* L.), roble colorado (*Tabebuia haemantha* (Bert.) DC.), bejuco de palma (*Trichostigma octandrum* (L.) H. Walt.) tachuelo (*Pictetia aculeata* (Vahl.) Urban), roble guayo (*Bourreria succulenta* Jacq.), escambrón tintillo (*Randia mitis* L.) and *Proustia Krugiana* Urban. Vines are abundant in the thickets and the most common are bejuco de sopla (*Elsota virgata* (Sw.) Kuntze), bejuco de costilla (*Serjania polyphylla* (L.) Radlk.), *Gouiana lipuloides* (L.) Urban and *Stigmaphillon lingulatum* (Poir.) Small. The bicornis (*Andropogon bicornis* L.) is the prevailing native grass on the hillsides. The herbaceous species are mostly weeds, including *Iresine Celosia* L. and bruja (*Bryophyllum pinnatum* (Lam.) Kurz.). The nidos de gungulén (*Tillandsia recurvata* L.) is abundant below and altitude of 300 meters, especially on the bucar (*B. buceras* L.) trees.

A comparison of species listed above with those of the climax forest of the region shows an extraordinary degree of resemblance, and leads to the conclusion that they represent and extension of the bucar (*Bucida buceras* L.) climax association of the foothills. The presence of this type of plant life on the foothills is primarily a matter of aridity, and we have no evidence that the boundary between it and the mesophytic forest above is in process of successional adjustment. It is obvious that continued erosion of the foothills tend to reduce them to a base level and thereby to produce the physiographic climax upon which the plant life is usual and best developed.

F. Summary

The plant life of the south shore is ecologically simple in comparison with that of the northern shore In a few areas only do the dynamic physiographic processess of beach formation or soil accumulation or humus formation, result in well-marked successional series These proceed from mangrove swamps, through reduction in water-content and salinity of soil, or from fresh-water lagoons, through reduction in the water supply, to the climax forest. Over most of this region dynamic changes have come nearly or quite to a standstill, and the plant life is in a climax or sub-climax condition. The climax forest, no longer existing in a natural condition, was apparently dominated by *Bucida buceras* L. and occupied the fertile soils of the foothills and the alluvial coastal plains. The sub-climax occupies the arid coastal hills of shale, serpentine and limestone, and is characterized by a group of species in which *Elaphrium*

simuraba (L.) Rose is most abundant Throughout this region, the most important environmental factor is water-supply

THE INFLUENCE OF AGRICULTURE ON THE ORIGINAL PLANT LIFE OF PORTO RICO

It will be readily seen that the plant life of Porto Rico, as it was when the first white settlements were made on the Island, has been greatly modified by activities of man This was to be expected; man always destroys vegetation in order that he may make use of products of nature and in order that he may utilize the land in accordance with his wishes If nature has been prolific, man does not stop when his own needs are supplied but usually destroys wantonly, forgetful that a time will come when he will need many products of nature that are no longer available Porto Rico has been no exception and has suffered from the avaricious and destructive spirit of man

The conditions are such that Porto Rico has been and probably will remain an agricultural country Therefore, the removal of the natural growth of plant life has been largely for the supplying of the needs of man and for the purpose of bringing the land under cultivation Unfortunately, the methods have in many cases been wasteful and the island would be much richer today if some of the natural resources had been conserved The destruction of the plant life has been so great some of the original plant associations have been completely destroyed while others can be traced only from small remaining fragments The realization that many of these fragments would soon be removed and this phase of the natural history forever lost, induced the authors to make this survey at this time We have traced the history of the plant life so far as possible in the short time alloted to the work and have discussed so far as possible its relation to the environmental agencies It now appears to be worth while to give a brief discussion of the agriculture that has followed this destruction of the products of nature

The early land policies of Spain appear to have been very liberal Large grants were made to the grandees and to the soldiers of fortune and small grants of little more than 170 acres to settlers However, the settlement of Porto Rico was very slow and by 1830 the Spanish Government had disposed of only about one half of the land of the island Following that date There was a rapid increase in population with a corresponding rapid increase in the utilization of the land, so that by 1898, the date of the Spanish

American War, nine-tenths of the remainder had been disposed off in various ways. By the treaty of Paris, Spain ceded to the United States Government, the Crown lands, estimated by Murphy at 147,971 acres, of which 7,400 acres were swamp. Practically all of these lands with some few additional acres, which have reverted in default of taxes, are now owned by the United States and the Insular Governments The utilization of the lands in 1928, 1900 and 1911 are shown in Fig. 70 which we have adopted from Murphy **(26)**. The fact that in 1828 less than 4 per cent of the area was under cultivation and that in 1900 less than 13 per cent, indicates that the agricultural exports of the Island were very limited However, the destruction of forests was probably greater than is indicated by the percentage under cultivation or in use for pasture It appears that the forest was frequently destroyed for growing of crops and that after three or four years, the land was abandoned and new clearings made

The great increase in population which began early in the nineteenth century naturally led to the removal of the forest over large areas in order that the land might be used for cultivation of crops that were becoming important for export and for the support of the increasing population

Sugar cane is the most important crop on the Island It was introduced early in the fifteenth century and has increased with the increase in population. Sugar is now about one-half or possibly a little more of the island export It grows best on the rich alluvial soils which made necessary the clearings of practically all of the lowlands around the coast and in the valleys, except the swamp areas that were too low for satisfactory drainage (Fig. 71) In recent years sugar cane has been grown extensively on the hills but it is doubtful if the area can be increased to any great extent except by the draining of a few remaining swamps

Coffee is the crop of second importance and although it is grown to some extent at elevations of not more than 35 meters (100 feet) the great commercial crop is grown on the volcanic soils at elevations ranging from 300 to 800 meters (1,500 to 2,500 feet) The limiting factors appear to be soil, rainfall and wind. The difference in the crop is very noticeable in passing from volcanic to limestone soils. High rainfall is necessary and this limits its production on the south side to the very high elevations and to the moist ravines. Strong winds are injurious and this appears to have been a factor in keeping it from going to higher elevations in the Luquillo Forests

and in the vicinity of Jayuya. Coffee is a shade-loving plant and it would at first appear that its cultivation would not necessarily require the removal of the forest. However, it requires an open shade which is furnished by the guaba (*Inga inga*) and the guamá (*I. laurina*) and it grows especially well under these two species. This has resulted in the removal of the major part of the original forests over the regions indicated and the extensive planting of these two species (Fig. 72). In some parts of the Island the plantations have been abandoned, probably as the result of the ravages of root diseases of the coffee, and area gradually reverting to the original conditions.

The cattle industry is quite extensive but not large enough to supply the needs of the Island. It occupies extensive areas of pasture land, much greater in proportion to the value of the industry than any other phase of agriculture. These pasture lands are most extensive in the semi-arid region of the south side of the Island between Guayama and Ponce and between the sea and the line of rainfall near the crest of the central range. There are also rather extensive pasture lands on the north coast west of Arecibo. In other parts of the Island small areas too rough for cultivation are used for pasture and the dairy interest utilizes small areas suitable for other purposes in the vicinity of the cities

The fruit industry is primarily along the north coast starting a short distance east of San Juan and extending to a short distance west of Arecibo. This industry consists mostly of citrus fruits and pineapple which are grown in the small valleys and over the low hills. The pineapple thrives best in volcanic soil and extends well to the south in the vicinity of Corozal. This crop also thrives on soils of limestone origin provided the lime has been well leached out or provided there is a high humus content. The leaching of the lime and humus accounts for the growing of this crop on the lower parts of the coastal plain. Oranges grow extensively without cultivation over the western part of the Island and pineapples are grown in the vicinity of Lajas. Aguacates, mangos and guavas grow without cultivation throughout the greater part of the island and can be grown extensively when the market makes it profitable to do so. In fact, the growing and preserving of some of these fruits may solve the problem of the more profitable utilization of some of the semi-arid lands of Porto Rico. Coconuts are grown along the coast, the most extensive plantings being around the eastern and western ends of the Island and in favorable locations along the south coast. It is doubt-

ful if this industry can be increased with profit to any great extent. (Fig. 73).

Tobacco is grown most extensively in the Cayey and Juncos valleys, especially the former which is given over almost entirely to this crop. The soil and climate of this region appears to be especially favorable for the growing of this crop although small plantings are to be found in other parts of the Island, especially along the north coast (Fig. 74).

Cotton is a minor crop grown extensively in the regions of low rainfall along the northwest coast and to some extent along the western half of the south coast (Fig. 75). This cotton is the sea-island variety and the industry can be materially increased.

The native vegetables for local consumption are grown throughout the Island and to some extent for the northern markets. The most important vegetable-growing district for export coincides with the fruit growing region of the north coast, east of Arecibo.

It will be readily seen that all of these industries have made necessary the removal of the vast forest which covered practically all the Island at the time of its discovery by Columbus. Hills and other regions which cannot be used for agriculture are cut over repeatedly in order to meet the needs of the growing population for fuel. The result is that there are very few fragments of the original plant life, aside from the high mountain region to which we have referred. The great value of most of the land for agricultural purposes will prevent reforestation to any great extent and reforestation will not mean restoration to original conditions at the time of the coming of the white men. However, there are many regions of Porto Rico that can be reforested to an advantage, and all the higher elevations should be under Government ownership or control so that the water may be conserved to the greatest good to the greatest number of our population.

COMMON NAMES

This list of common names was prepared from information obtained from many sources. The cross reference numbers following the names will enable the reader to learn when a plant is known by two or more common names.

1. Abejuelo—*Colubrina colubrina* (Jacq.) Mills. 8.
2. Abrojo—*Cenchrus echinatus* L.
3. Acacia—*Leucaena glauca* (L.) Benth. 4, 124, 285.
4. Acacia pálada—*Leucaena glauca* (L.) Benth. 3, 124 285.
5. Acana—*Manilkara nitida* (Sessé & Moc.) Dubard. 316.

6. Aceitillo—*Simaruba tulae* Urban.
7. Achicoria cimarrona—*Tupa robusta* (Graham) A. DC. 161.
8. Achiotillo—*Colubrina colubrina* (Jacq.) Mills. 1.
9. Achiotillo—*Alchornea latifolia.* Sw. 327, 458.
10. Adormida—*Croton rigidus* (Muell Arg.) Britton. 275.
11. Aguacate cimarrón—*Hufelandia pendula* (Sw.) Nees. 152, 152.
12. Aguacatilla—*Meliosma herberti* Rolfe. 101.
13. Aguinaldo blanco—*Jacquemontia nodiflora* (Des.) G. Don.
14. Aguinaldo de costa—*Jacquemontia jamaicensis* (Jacq.) Hall.
15. Alelí cimarrón—*Plumiera alba.* L. 167, 559.
16. Algarroba—*Hymenaea courbaril* L.
17. Algodón de seda—*Calotropis procera* Ait. R. Br. 416.
18. Almácigo—*Elaphrium Simaruba* (L) Rose.
19. Almendra—*Terminalia catappa* L.
20. Almendrón—*Dipholis salicifolia* (L.) A. DC.
21. Altea—*Nepsera aquatica* (Aubl.) Naud.
22. Amarat—*Acacia muricata* (L.) Willd.
23. Angela—*Moringa moringa* (L.) Millsp. 76, 321.
24. Anguila—*Eugenia buxifolia* (Sw.) Willd. 29.
25. Añil—*Indigofera suffruticosa* Mill.
26. Añil (falso)—*Benthamantha caribaea* (Jacq.) Kuntz.
27. Aquilón—*Laugeria resinosa* Vahl.
28. Arayanilla—*Ascyrum hypericoides* L.
29. Arguilo—*Eugenia buxifolia* (Sw.) Willd. 24.
30. Aroma—*Lasianthus moralesii* (Grisseb.) C. Wright. 397.
31. Aroma—*Vachellia farnesiana* (L.) W. & A. 32,
32. Aroma casha—*Vachellia farnesiana* (L.) W. & A. 31.
33. Arrayán—*Myrica cerifera* L. 158.
34. Arrayán—*Rapanea ferruginea* (R. & P.) Mez. 196, 375.
35. Arroyo—*Meliosma obtusifolia* (Bello) K. & U. 98, 168, 169, 279, 280.
36. Avispillo—*Nectandra coriacea* (Sw.) Griseb. 335.
37. Avispillo—*Turpinia paniculata* Vent. 642.
38. Avispillo—*Phoebe montana* (Sw.) Griseb.
39. Avispillo—*Margarita nobilis* L. 629, 654, 659.
40. Avispillo—*Mayepea caribaea* (Jacq.) Kuntze.
41. Azota caballo—*Malpighia coccigera* L.
42. Azúcares—*Jacquinia barbasco* (Loefl.) Mez. 49.
43. Babiero amarillo—*Urechtites lutea* (L.) Britton.
44. Badula—*Icacorea guadalupensis* (Duch.) Britton. 374.
45. Badula—*Rapanea guianensis* (Aubl.)
46. Bálsamo—*Citharexylum fruticosum* L. 465, 493.
47. Bálsamo—*Hamelia axilaris* Sw.
48. Bambú trepador—*Arthrostylidium sarmentosum* Pilger.
49. Barbasco—*Jacquinia barbasco* (Loefl.) Mez. 42.
50. Barbasco—*Canella winterana* (L.) Gaertn. 133.
51. Barbas de úcar—*Dendropogon usneoides* (L.) Raf.
52. Bariaco—*Krugiodendron ferreum* (Vahl.) Urban. 223, 467, 647.
53. Bariacao—*Trichilia triacantha* Urban. 683.
54. Barilla—*Batis maritima* L. 593.

55. Basora—*Varronia angustifolia* West.
56. Basquiña—*Pothomorphe peltata* (L.) Mig.
57. Batatilla—*Ipomoea stolonifera* (Cyrill.) Poir. 633.
58. Begonia—*Begonia decandra* Pav.
59. Bejuco de berraco—*Chiococca alba* (L.) Hitch.
60. Bejuco de buey—*Banisteria laurifolia* L. 484.
61. Bejuco de costilla—*Serjania polyphylla* (L.) Radlk. 632.
62. Bejuco de garrote—*Rourea surinamensis* Miq. 664.
63. Bejuco de guajanilla—*Paullinia pinnata* L. 66.
64. Bejuco de inglés—*Capparis cynophallophora* L.
65. Bejuco de mona—*Cissampelos pareira* L. 485.
66. Bejuco de palma *Paullinia pinnata* L. 63.
67. Bejuco de paloma—*Trichostigma octandrum* (L.) H. Walt.
68. Bejuco de palma—*Marcgravia rectiflora* Tr. & Pl. 488.
69. Bejuco de playa.—*Ipomoea Pes-Caprae* (L.) Roth.
70. Bejuco de prieto—*Hippocratea volubilis* L.
71. Bejuco de rana *Marcgravia sintenisii* Urban.
72. Bejuco de Santiago—*Aristolochia trilobata* L. 105, 482.
73. Bejuco de sopla—*Elsota virgata* (Sw.) Kuntz. 313.
74. Bejuco de toro—*Stigmaphyllon tomentosum* (Desf.) Ndz.
75. Bellorita—*Erigeron bellioides* D. C.
76. Ben—*Moringa moringa* (L.) Millsp. 23, 321.
77. Berenjena cimarrona—*Solanum torvum* Sw.
78. Berenjena de playa—*Solanum persicifolium* Dunal.
79. Bertonica afellfada—*Moluchia tormentosa* L.
80. Bicornis—*Andropogon bicornis* L.
81. Bijao—*Alpinia aromatica* Aubl. 419.
82. Birijí—*Eugenia monticola* (Sw.) DC. 300.
83. Borborón—*Scaevola plumierii* L. 84, 183.
84. Borborón de playa - *Scaevola plumierii* L. 83, 183.
85. Botón blanco—*Borreria verticillata* (L.) Meyer.
86. Botón de oro—*Volkameria aculeata* L. 216.
87. Botón de oro—*Melampodium divaricatum* (L. C. Rich.) DC.
88. Botoncillo—*Conocarpus erecta* L.
89. Botoncillo—*Borreira ocimoides* (Burm.) DC.
90. Botoncillo—*Gnaphalium portoricense* Urban.
91. Botoncillo—*Dichromena ciliata* Vahl.
92. Bruja—*Byrophyllum pinnatum* (Lam.) Kruz.
93. Búcar. *Bucida buceras* L. 577.
94. Burro—*Capparis coccolobifolia* Mart.
95. Burro blanco—*Capparis portoricensis* Urban.
96. Cabai nagte—*Randia mitis* L. 215, 218, 459, 573.
87. Cabo de hacha—*Trichilia hirta* L.—328, 409, 442, 523 656, 692.
98. Cacaillo—*Meliosma obtusifolia* (Bello) K. & U. 35, 168, 169, 279, 280.
99. Cacaillo—*Slonaea breteriana* Choisy. 103, 415, 536.
100. Cacaillo—*Octoea leucoxylon* (Sw.) Mez.
101. Cacao bobo—*Meliosma herberti* Rolfe. 12.
102. Cacao rojo—*Sarcomphalus recticulatus* (Vahl.) Urban. 648.
103. Cacao roseta—*Slonaea berteriana* Choisy. 99, 536, 415.

104 Cachimba—*Dendropanax arboreum* (L.) Dcne. & Pl. 418, 450.
105 Cachimbos—*Aristolochia trilobata* L. 72, 483
106 Cachimba—*Rauwolfia tetraphylla* L. 441, 473
107 Cachimba—*Palicourea crocea* (Sw.) R. & S.
108 Cachimba—*Psychotria pubescens* Sw.
109 Cadillo de ciénaga—*Malache scabra* B. Vogel
110 Cafeíllo—*Casearia guianensis* (Aubl.) Urban
111 Cafeíllo—*Drypetes alba* Poit. 308, 481
112 Cafeíllo—*Faramea occidentalis* (L.) A. Rich. 682
113 Cafeíllo cimarrón—*Casearia sylvestris* Sw. 516, 550
114 Caimitillo—*Micropholis garciniifolia* Pierre
115 Caimito de perro—*Chrysophyllum pauciflorum* Lam.
116 Calabazón—*Philodendron krebsii* Schott
117 Calambreña—*Coccolobis venosa* L.
118 Camasey—*Miconia laevigata* (L.) DC.
119 Camasey—*Miconia hirta* (L.) D. Don
120 Camasey—*Miconia prasina* (Sw.) DC.
121 Camasey—*Miconia racemosa* (Aubl.) DC.
122 Camasey—*Clidemia hirta* (L.) D. Don
123 Camasey de charco—*Acisanthera acisanthera* (L.) Britton
124 Campeche—*Leucaena glauca* (L.) Benth. 3, 4, 285
125 Campeche—*Haematoxylon campechianum* L.
126 Caña cimarrona—*Gynerium sagittatum* (Aubl.) Beauv. 128, 637
127 Caña india—*Phragmites phragmites* (L.) Karst.
128 Caña india—*Gynerium sagittatum* (Aubl.) Beauv. 126, 637
129 Canario—*Allamanda cathartica* L. 628, 640
130 Canela—*Acrodiclidium salicifolium* (Sw.) Griseb. 134
131 Canela—*Ocotea wrightii* (Meissn.) Mez 639
132 Canela—*Persea krugii* Mez
133 Canela—*Canella winterana* (L.) Gaertn. 50
134 Canelillo—*Acrodiclidium salicifolium* (Sw.) Griseb. 130
135 Canelillo—*Aniba bracteata* (Nees) Mez
136 Capá amarillo—*Petitia domingensis* Jacq.
137 Capá cimarrón—*Cordia borinquensis* Urban 417
138 Caracolillo—*Phlebotaenia cowellii* Britton 140, 479, 641
139 Caracolillo—*Casearia decandra* Jacq. 182, 188, 246, 443
140 Caracolillo—*Phlebotaenia cowellii* Britton 138, 479, 641
141 Caracolillo—*Trichilia pallida* Sw. 237, 238, 517
142 Caracolillo—*Sabinea punicea* Urban
143 Caracolillo—*Homalium racemosum* Jacq.
144 Carraquillo—*Lantana camara* L. 546
145 Carraquillo de Santa María—*Lantana involucrata* L.
146 Carmín—*Rivina humilis* L.
147 Carruzo—*Ichnanthus pallens* (Sw.) Munro
148 Carruzo—*Panicum trichanthum* Nees
149 Carubio—*Zanthoxylum monophyllum* (Lam.) P. Wilson 385, 538, 672
150 Castilla—*Gynerium sagittatum* (Aubl.) Beauv.
151 Ceboruquillo—*Thouinia striata* (Radlk.) Britton 269, 508

152. Cedro macho—*Hufelandia pendula* (Sw.) Nees. 11, 452.
153. Cedro macho—*Hyeronima clusioides* (Tul.) Muell.
154. Ceiba—*Ceiba pentandra* (L.) Gaertn.
155. Cenizo—*Xanthoxylum martinicense* (Lam.) DC. 225.
156. Cenizo—*Tetrazygia eleagonoides* (Sw.) DC. 666, 697.
157. Cerisa—*Cordia nitidia* Vahl. 673.
158. Cerezo—*Myrica cerifera* L. 33.
159. Chamiso—*Dodonaea viscosa* Jacq. 282, 652.
160. Chicharrón—*Reynosia uncinlata* Urban.
161. Chicoria cimarrona—*Tupa robusta* (Graham) A. DC. 7.
162. Chiggernit—*Tournefortia hirsutissima* L.
163. Cieniguillo—*Daphnopsis philippiana* K. & U. 363, 507, 668.
164. Cieniguillo—*Myrcia deflexa* (Poir.) DC.
165. Cieniguillo—*Eugenia confusa* DC.
166. Cieniguillo—*Gomidesia lindeniana* Berg.
167. Cimarrón—*Plumiera alba* L. 15, 559.
168. Ciralillo—*Meliosma obtusifolia* (Bello) K & U. 35, 98, 169. 279, 280.
169. Cirnelillo—*Meliosma obtusifolia* (Bello) K. & U. 35, 98, 279, 230.
170. Clavelón de playa—*Borrichia arborescens* (L.) DC.
171. Cobana—*Stahlia monosperma* (Tul.) Urban. 501.
172. Cocorroncito—*Gyminda latifolia* (Sw.) Urban. 367.
173. Cocuisa—*Cordyline guineensis* (L.) Britton.
174. Cocuisa—*Furcraea tuberosa* Ait. 667.
175. Cocuisa—*Quisqualis indica* L. 689.
176. Cojóbana—*Piptadenia peregrina* (L.) Benth. 179, 498.
177. Cojóbana—*Piptadenia arboreum* (L.) Urban.
178. Cojóbana—*Acacia muricata* (L.) Willd.
179. Cojobillo—*Piptadenia peregrina* (L.) Benth. 176, 498.
180. Cojobillo—*Anneslia portoricensis* (Jacq.) Britton. 698.
181. Colaba—*Calophyllum antillanum* Britton. 243, 391, 470, 544.
182. Colorrerillo—*Caseria decandra* Jacq. 139, 188, 246, 443.
183. Coralillo—*Scaevola plumierii* (L.) Vahl 83, 84.
184. Corazón—*Annona glabra* L.
185. Corcho—*Torrubia fragrans* (Dum.—Cours.) Standley, 362, 364.
186. Corcho—*Ochroma pyramidale* (Cav.) Urban. 262.
187. Corcho—*Pisonia subcordata* Sw. 189, 678.
188. Corcho blanco—*Casearia decandra* Jacq. 139, 182, 246, 443.
189. Corcho bobo—*Pisonia subcordata* Sw. 187, 678.
190. Corita—*Agave missionum* Trell.
191. Corozo palma—*Acrocomia aculeata* (Jacq.) Lodd. 254, 655.
192. Coscorrán—*Elaeodendrum xylocarpum* (Vent) DC. 277.
193. Cotorra—*Ricinella ricinella* (L.) Britton. 212, 224.
194. Cotorrera de la playa—*Heliotropium curasavicum* L.
195. Cucubano—*Coccolobis laurifolia* Jacq. 245, 585, 653.
196. Cucubano—*Rapanea ferruginea* (R. & P.) Mez. 34, 375.
197. Cuernocillo—*Helicteres jamaicensis* Jacq. 310.
198. Cuernocillo—*Morongia portoricensis* (Urb.) Britton.
199. Cuero de sapo—*Exostema caribaeum* (Jacq.) R. & S. 338.

200. Cupeillo—*Clusia krugiana* Urban.
201. Cupey—*Clusia rosea* Jacq.
202. Cupey de altura—*Clusia gundlachii* Stahl.
203. Desmanto—*Acuan virgatum* (L.) Medic. 669.
204. Dildo—*Cephalocereus royeni* (L.) B. & R. 551.
205. Dildo—*Cephalocereus nobilis* (Haw.) B. & R.
206. Dunguey—*Similax coriacea* Spreng.
207. Dunguey—*Dioscorea pilosiuscula* Bertero.
208. Emajagua—*Pariti tiliaceum* (L.) St. Hil. 361, 358, 366.
209. Encinillo—*Drypetes ilicifolia* K & U.
210. Eneas—*Typha angustifolia* L.
211. Erizo—*Pitcairnia augustifolia* (Sw.) Redoubte. 496.
212. Escambrón—*Ricinella ricinella* (L.) Britton. 193, 224.
213. Escambrón—*Drepanocarpus lunatus* (C.) G. F. W. Meyer. 469.
214. Escambrón—*Pisonia aculeata* L. 582.
215. Escambrón—*Randia mitis* L. 96, 218. 459, 573.
216. Escambrón blanco—*Volkameria aculeata* L. 86.
217. Escambrón colorado—*Pithecellobium unguis-cati* (L.) Mart. 533, 581.
218. Escambrón tintillo—*Randia mitis* L. 96. 215, 459, 573.
219. Escobita—*Scoparia dulcis* L. 220, 395, 432.
220. Escobita amarga—*Scoparia dulcis* L. 219. 395. 432.
221. Espejuelo—*Sarcomphalus reticulatus* (Vahl.) Urban. 102.
222. Espejuelo—*Dipholis sintenisiana* Pierre.
223. Espejuelo—*Krugiodendron ferreum* (Vahl.) Urban. 52, 467, 647.
224. Espinillo—*Ricinella ricinella* (L.) Britton. 193. 212
225. Espinosa—*Zanthoxylum martinicense* (Lam.) DC. 155.
226. Espinosa—*Anthacanthus spinosus* (Jacq.) Nees.
227. Flamboyant *Delonix regia*—(Bojer) Raf. 537.
228. Flamboyant blanco—*Bauhinia monandra* Kurz. 555. 588.
229. Flor de agua—*Piaropus crassipes* Mart.) Britton.
230. Flor de agua—*Castalia ampla* Salisb.
231. Flor de Culebra—*Anthurium acaule* (Jacq.) Schott. 297. 107.
232. Flor de mayo—*Parkinsonia aculeata* L. 478.
233. Flor de mayo—*Selenicereus pteranthus* L. & O., B. & R.
234. Flor de todo el año—*Catharanthus roseus* (L.) Don.
235. Forte Ventura—*Lonchocarpus latifolius* (Willd.) HBK. 466.
236. Fresa—*Rubus rosaefolius* Smith. 623.
237. Gai—*Trichilia pallida* (Sw.) 141. 238. 517.
238. Gaita—*Trichilia pallida* (Sw.) 141. 237, 517.
239. Gaita—*Exothea paniculata* (Juss.) Radlk. 256.
240. Gaita—*Samyda spinulosa* Vent.
241. Galán del monte—*Cestrum laurifolium* L'Her.
242. Galán del monte—*Cestrum macrophyllum* Vent.
243. Galba—*Calophyllum antillanum* Britton. 181. 391. 470. 544.
244. Garrocho—*Quararibaea turbinata* (Sw) Poir.
245. Garcado—*Coccolobis laurifolia* Jacq. 195. 585. 653.
246. Gia mansa—*Casearia decandra* Jacq. 139, 182, 188, 443.
247. Gongolí—*Dendropanax laurifolium* (E. March) Dcne. & Pl. 482, 680.

248. Grama blanca—*Stenotaphrum secundatum* (Walt.) Kuntz.
249. Granadilla—*Buchenavia capitata* (Vahl.) Eichl.
250. Granadilla—*Eugenia lingustrina* (Sw.) Willd. 471.
251. Granadillo—*Ocotea spathulata* Mez. 421, 643.
252. Grasilla—*Setiscapella subulata* (L.) Barnh.
253. Yagrumo—*Didymopanax morototoni* (Aubl.) Dcne. & Pl. 353, 354.
254. Grugrú—*Acrocomia aculeata* (Jacq.) Lodd. 191, 655.
255. Guaba—*Inga inga* (L.) Britton.
256. Guaracán—*Exothea paniculata* (Juss.) Radlk. 239.
257. Guácima—*Guazuma guazuma* (L.) Cockerell.
258. Guaco—*Mikania congesta* DC.
259. Guaco—*Mikania cordifolia* (L.) Willd.
260. Guadillo—*Guarea ramiflora* Vent. 266,
261. Guamá—*Inga laurina* (Sw.) Willd.
262. Guano—*Ochroma pyramidale* (Cav.) Urban.
263. Guano—*Arundo donax* L. 638.
264. Guao—*Comocladia glabra* (Schultes.) Spreng.
265. Guara blanca—*Cupania americana* L.
266. Guara-guadillo—*Guarea ramiflora* Vent. 260.
267. Guaraguao—*Guarea guara* (Jacq.) P. Wilson.
268. Guarema—*Picramnia pentandra* Sw. 307.
269. Guava—*Thyana striata* (Radlk) Britton. 151, 508
270. Guayabacoa—*Rheedia acuminata* (Spreng.) Tr. & Pl. 553.
271. Guayabota—*Eugenia Stahlia* (Kiaersk.) K & U.
272. Guayabota—*Diospyros ebenaster* Retz. 278.
273. Guayabota—*Maba sintenisii* K. & U. 561.
274. Guayacán—*Guaiacum officinale* L. 348.
275. Guayacanillo—*Croton rigidus* (Muell. Arg.) Britton. 10.
276. Guayacanillo—*Guaiacum sanctum* L. 657.
277. Guayavota—*Elaeodendrum xylocarpum* (Vent.) DC. 192.
278. Guayavota—*Diospyros ebanester* Retz. 272.
279. Guayavota—*Meliosma obtusifolia* (Bello) K. & U. 98, 168, 169, 280.
280. Guayaroto—*Meliosma obtusifolia* (Bello) K. & U. 98, 168, 169, 279.
281. Guinda—*Anthurium scandens* (Aubl.) Engler.
282. Guitaran—*Dodonaea viscosa* Jacq. 159, 652
283. Gungulén—*Vanilla Eggersii* Rolfe.
284. Haya-minga—*Cananga blainii* (Griseb.) Britton. 420.
285. Hediondilla—*Leucaena glauca* (L.) Benth. 3, 4, 124.
286. Hediondilla—*Chamaefistula antillana* B. & R
287. Hediondilla—*Chamaecrista diphylla* (L.) Greene.
288. Hediondilla—*Peiranisia polyphylla* (Jacq.) B. & R. 525.
289. Higüera—*Crescentia cujete* L.
290. Higüerillo—*Enallagma latifolia* (Mill.) Small.
291. Higüerillo—*Citharexylum caudatum* L.
292. Higüerillo—*Vitex divaricata* Sw. 685.
293. Higuillo—*Piper amalago* L. 294.
294. Higuillo de limón—*Piper amalago* L. 293.

295. Higuillo de limón—*Piper aduncum* L. 303.
296. Higuillo de limón—*Margaritaria nobilis* L.
297. Hoja de costado—*Anthurium acaule* (Jacq.) Schott 231, 407.
298. Hoja menuda—*Myrcia citrifolia* (Aubl.) Urban
299. Hoja menuda—*Myrcia splendens* (Sw.) DC.
300. Hoja menuda—*Eugenia monticola* (Sw.) DC. 82
301. Hoja menuda—*Eugenia lancea* Poir. 687.
302. Hoja menuda—*Eugenia procera* (Sw.) Poir.
303. Hoja menuda—*Piper aduncum* L. 295
304. Hoja menuda—*Calyptranthes sintenisii* Kiaresk. 349.
305. Horquetilla—*Chloris radiata* (L.) Sw.
306. Huesillo—*Mayepea domingensis* (Lam.) K. & U. 309.
307. Hueso—*Picramnia pentandra* Sw. 268
308. Hueso—*Drypetes alba* Poit. 111, 481.
309. Hueso blanco—*Mayepea domingensis* (Lam.) K. & U. 306.
310. Huevo de gato—*Helicteres jamaicensis* Jacq. 197
311. Icaco—*Chrysobalanus icaco* L.
312. Icaquillo—*Hirtella rugosa* Pers. 571.
313. Jaboncillo—*Elsota virgata* (Sw.) Kuntze 73
314. Jaboncillo—*Sapindus saponaria* L.
315. Jácana—*Lucuma multiflora* A. DC.
316. Jácana—*Manilkara nitida* (Sessé & Moc.) Dubard. 5.
317. Jacanillo—*Petesioides pendulum* (Urban) Britton. 511, 662.
318. Jaguey—*Ficus laevigata* Vahl. 326, 337, 634.
319. Jaguey—*Ficus Stahlii* Warb.
320. Jaguey—*Ficus urbaniana* Warb.
321. Jasmín—*Moringa moringa* (L.) Millsp. 23, 76
322. Jasmín—*Jasminum grandiflorum* L.
323. Jayajabico—*Erithalis fruticosa* L.
324. Jiba—*Schaefferia frutescens* Jacq.
325. Jiba—*Erythroxylon brevipes* DC.
326. Jiguerillo—*Ficus laevigata* Vahl. 318, 337, 634.
327. Jobillo—*Alchornea latifolia* Sw. 9, 458.
328. Jobillo—*Trichilia hirta* L. 97, 409, 442, 523, 656, 692.
329. Jobo—*Spondias mombin* L.
330. Juzo—*Rochefortia acanthophora* DC. Griseb.
331. Junco cimarron—*Cyperus articulatus* L.
332. Junco de espiga—*Eleocharis interstincta* (Vahl.) R. & S.
333. Junquito—*Fimbristylis diphylla* (Retz.) Val.
334. Karrebesu—*Pictetia aculeata* (Vahl) Urban 563.
335. Laurel—*Nectandra coriacea* (Sw.) Griseb. 36.
336. Laurel roseta—*Nectandra patens* (Sw.) Griseb.
337. Lechecillo—*Ficus laevigata* Vahl. 318, 326, 634.
338. Lechecillo—*Erostema caribaeum* (Jacq.) R. & S. 199.
339. Lechecillo—*Chrysophyllum bicolor* Poir. 636.
340. Lechecillo—*Croton discolor* Willd.
341. Lechecillo—*Chamaesyce prostata* (Aiton) Small
342. Lechecillo—*Sapium laurocerasus* Desf. 660, 661.
343. Lechuguilla de agua—*Pistia stratiotes* L.
344. Lengua de vaca—*Anthurium dominicense* Schott.

345. Lengua de vaca—*Elephantopus mollis* HBK.
346. Liana fragante—*Distictis lactiflora* (Vahl.) DC. 436, 598.
347. Liaña uñada—*Batocydia unguis* (L.) Mart. 490, 579.
348. Lignum vita—*Guaiacum officinale* L. 274.
349. Limoncillo de monte—*Calyptranthes sintenisii* Kiaersk. 304.
350. Lirio—*Hymenocallis declinata* (Jacq.) M. Roem.
351. Lirio—*Strumfia maritima* Jacq.
352. Llagrumo—*Cecropia peltata* L.
353. Llagrumo—*Didymopanax morotoni* (Aubl.) Dcne. & Pl. 253, 354.
354. Llagrumo macho—*Didymopanax morototoni* (Aubl.) Dcne. & Pl. 253, 353.
355. Llume—*Gaussia attenuata* (Cook) Beccari.
356. Madreselva—*Pilea microphylla* (L.) Liebm. 594.
357. Madreselva—*Leonicera japonica* Thunb.
358. Mahoe—*Pariti tiliaceum* (L.) St. Hil. 208, 361, 366.
359. Maíz pelado—*Comocladia dodonaea* (L.) Urban. 360, 506.
360. Maíz tostado—*Comocladia dodonaea* (L.) Urban. 359, 506.
361. Majagua—*Pariti tiliaceum* (L.) St. Hil. 208, 358, 366.
362. Majagua—*Torrubia fragrans* (Dum-Cours.) Standley. 185, 364.
363. Majagua brava *Daphnopsis philippiana* K & U. 163, 507, 668.
364. Majagua que mona—*Torrubia fragrans* (Dum.—Cours.) Standley. 185, 362.
365. Malagueta—*Amomis caryophyllata* (Jacq.) K & U. 630.
366. Malagueta—*Pariti tiliaceum* (L.) St. Hil. 208, 358, 361.
367. Mala mujer—*Gyminda latifolia* (Sw.) Urban. 172.
368. Malvavisco—*Corchorus hirtus* L.
369. Malvavisco—*Malachra urens* Poit.
370. Malvavisco—*Malvastrum coromandelianum* (L.) Gracke.
371. Malvavisco—*Waltheria americana* L. 631.
372. Mamey—*Mammea americana* L.
373. Mameyuelo—*Manilkara duplicata* (Sesse & Moc.) Dubard. 549.
374. Mameyuelo—*Icacorea guadalupensis* (Duch.) Britton. 44.
375. Mameyuelo—*Rapanea ferruginea* (R. & P.) Mez. 34,375.
376. Mangle—*Rhizophora mangle* L. 380, 381.
377. Mangle blanco—*Laguncularia racemosa* (L.) Gaertn.
378. Mangle bobo—*Avicennia nitida* Jacq.
379. Mangle botón—*Conocarpus erecta* L.
380. Mangle Colorado—*Rhizophora mangle* L. 376, 381.
381. Mangle zapatero—*Rhizophora mangle* L. 376, 380.
382. Mango—*Mangifera indica* L.
383. Manto—*Rhacoma crossopetalum* L. 387.
384. Manzanilla—*Wedelia trilobata* (L.) Hitch.
385. Mopurito—*Zanthoxylum monophyllum* (Lam.) P. Wilson. 149, 538, 672.
386. Maray-maray—*Ecastophyllum ecastophyllum* (L.) Britton. 476.
387. Maravedí—*Rhacoma crossopetalum* L. 383.
388. Margarita—*Bidens pilosa* L. 694.
389. Margarita—*Browallia americana* L. 686.

390. Margarita silvestre—*Bidens pilosa* L.
391. María—*Calophyllum antillanum* Britton. 181, 243, 470, 544.
392. Maricao—*Byrsonima spicata* (Cav.) DC.
393. Maricao—*Haemocharis portoricensis* K. & U. 424.
394. Masa—*Tetragastris balsamifera* (Sw.) Kuntze. 456.
395. Mastuerzo—*Scoparia dulcis* L. 219, 220, 432.
396. Mato azul—*Guilandina crista* (L.) Small. 398.
397. Mato de peo—*Lasianthus moralesii* (Griseb.) C. Wright. 30.
398. Mato de playa—*Guilandina crista* (L.) Small. 396.
399. Mato de playa—*Canavali maritima* (Aubl.) Thou.
400. Mato mariposa—*Duggena hirsuta* (Jacq.) Britton 475, 512, 616.
401. Matojo de playa—*Sporobolus virginicus* (L.) Kunth.
402. Matraca—*Crotalaria retusa* L. 558.
403. Maya—*Bromelia pinguin* L. 497.
404. Melón de costa—*Cactus intortus* Mill
405. Mesquite—*Prosopis juliflora* (Sw.) DC.
406. Moca—*Andira inermis* H. B. K.
407. Moca de pavo—*Anthurium acaule* (Jacq.) Schott. 231, 297.
408. Moco de pavo—*Amaranthus cruentus* L.
409. Molinillo—*Trichila hirta* L. 97, 328, 442, 523, 656, 692.
410. Molinillo—*Hura crepitans* L. 663.
411. Molinillo *Leonotis nepetaefolia* (L.) R. Br. 635
412. Moral—*Cordia sulcata* DC.
413. Moralón—*Coccolobis Grandifolia* Jacq.
414. Mostacilla del mar—*Cakile lanceolata* (Willd.) O. E. Schultz.
415. Motillo—*Slonaea berteriana* Choisy. 99, 103, 536.
416. Mudar—*Calotropis procera* (Ait.) R. Br. 17.
417. Muñeca—*Cordia borinquensis* Urban. 137.
418. Muñeca—*Dendropanax arboreum* (L.) Dcne. & Pl. 104, 450.
419. Narciso—*Alpinia aromatica* Aubl. 81.
420. Negralora—*Cananga blainii* (Grieseb.) Britton. 284.
421. Nemocá—*Ocotea spathulata* Mez 251, 643.
422. Nemocá—*Octoea moschata* (Pavon) Mez. 675, 676, 677.
423. Nidos de gungulén—*Tillandsia recurvata* L.
424. Niño de cota—*Haemocharis portoricensis* K. & U. 393.
425. Noyo—*Ipomoea dissecta* (Jacq.) Pursh.
426. Ohulaga—*Opuntia repens* Bello. 427.
427. Olaga—*Opuntia repens* Bello. 426.
428. Olaga—*Malpighia fucata* Ker.
429. Oreganillo—*Weinmania pinnata* L.
430. Oreganillo—*Cynometra portoricensis* K. & U.
431. Oreganillo—*Eupatorium dolicholepsis* (Urban) Britton.
432. Orozuz—*Scoparia dulcis* L. 219, 220, 305.
433. Orozus—*Leptilon pusillum* (Nutt.) Britton. 684.
434. Orozuz—*Stemodia maritima* L.
435. Ortegón—*Coccolobis rugosa* Desf.
436. Pega Palo—*Distictis lactiflora* (Vahl.) DC 346, 489, 598.
437. Palinguán—*Capparis flexuosa* L. 457.
438. Palmo de coyor—*Bactris acanthophylla* Mart., 644.
439. Palma de coyor—*Euterpe globosa* Gaertn.

440. Palma real—*Roystonea borinqueña* Cook.
441. Palo amargo—*Rauwolfia tetraphylla* L. 106, 473.
442. Palo anastacia—*Trichilia hirta* L. 97, 328, 409, 523, 692.
443. palo blanco—*Casearia decandra* Jacq. 139, 182, 188, 246.
444. Palo blanco—*Allophylus occidentalis* (Sw.) Radlk. 509.
445. Palo blanco—*Chione venosa* (Sw.) Urban. 671.
446. Palo blanco—*Drypetes glauca* Vahl. 587.
447. Palo bobo—*Pisonia subcordata* Sw.
448. Palo bobo—*Brunellia comocladifolia* H. & B.
449. Palo bobo—*Coccolobis diversifolia* Jacq.
450. Palo cachimba—*Dendropanax arboreum* (L.) Dcne. & Pl. 104, 418.
451. Palo cachimba—*Psychotria brachiata* Sw.
452. Palo colorado—*Hufelandia pendula* (Sw.) Nees. 11, 152.
453. Palo colorado—*Taonabo luquillensis* (K. & U.) Britton.
454. Palo colorado—*Myroxylon schwaneckeanum* K. & U. 679.
455. Palo moro—*Psychotria undata* Jacq.
456. Palo de aceite—*Tetragastris balsamifera* (Sw.) Kuntz. 349
457. Palo de burro—*Capparis flexuosa* L. 437.
458. Palo de cotorra—*Alchornea latifolia* Sw. 9, 327.
459. Palo de cotorra—*Randia mitis* L. 96, 215, 218, 573.
460. Palo de cucubano—*Guettarda scabra* (L.) Lam.
461. Palo de dajao—*Ixora ferrea*, (Jacq.) Benth. 468.
462. Palo de gallina—*Alchorneopsis portoricensis* Urban.
463. Palo de gallina—*Acnistus arborescens* (L.) Schlecht. 649.
464. Palo de gallina—*Elcisine indica* (L.) Gaertn.
465. Palo de guitarra—*Citharexylum fruticosum* L. 46, 493.
466. Palo de hedionda—*Lonchocarphus latifolius* (Willd.) HBK. 235.
467. Palo de hierro—*Krugiodendrom ferreum* (Vahl.) Urban. 52, 223, 647.
468. Palo de hierro—*Ixora ferrea* (Jacq.) Benth. 461.
469. Palo de hoz—*Drepanocarpus lunatus* (C.) G. F. W. Meyers. 213. 391, 544.
470. Palo de María—*Calophyllum antillanum* Britton. 181, 243, 391, 544.
471. Palo de multa—*Eugenia lingustrina* (Sw.) Willd. 250.
472. Palo de muñeco—*Cordia glabra* L.
473. Palo de muñeco—*Rauwolfia tetraphylla* L. 106, 441.
474. Palo de muñeco—*Cordia glabra* L.
475. Palo de pelado—*Duggena hirsuta* (Jacq.) Britton. 400, 512, 616.
476. Palo de pollo—*Ecastophyllum ecastophyllum* (L.) Britton. 386.
477. Palo de pollo—*Pterocarpus officinalis* Jacq.
478. Palo de rayo—*Parkinsonia aculeata* L. 232.
479. Palo de tortuga—*Phlebotaenia cowellii* Britton. 138, 140, 641.
480. Palo de vaca—*Bourreria succulenta* Jacq. 531.
481. Palo de vaca—*Drypetes alba* Poit. 111, 308.
482. Palo de vaca—*Dendropanax laurifolium* (E. March) Dcne. & Pl. 247, 680.

483. Panitos—*Aristolochia trilobata* L. 72, 105.
484. Paralejo—*Banisteria laurifolia* L. 60.
485. Parriera—*Cissampeles pareira* L. 65.
486. Pata de gallina—*Lepidagathis alopecuroidea* (Vahl.) R. Br.
487. Pata de gallina—*Phoradendron chrysocarpum* K. & U.
488. Pega palma—*Marcgravia rectiflora* Tr. & Pl. 68.
489. Pega palo—*Distictis latiflora* (Vahl.) DC. 346, 436,
490. Pega palo—*Batocydia unguis* (L.) Mart. 347, 579.
491. Pega pollo—*Commicarpus scandens* (L.) Standley.
492. Pega pollo—*Alsine antillana* (Urb.) B. & W.
493. Pédula—*Cithrarexylum fruticosm* L. 46, 465.
494. Peronía—*Abrus abrus* (L.) W. F. Wight.)
495. Peronía—*Armosia krugii* Urban.
496. Piña de cuervo—*Pitcairnia angustifolia* (Sw.) Redoubte. 211.
497. Piñuela—*Bromelia pinguin* L. 403.
498. Piptadenia—*Piptadenia peregrina* (L.) Benth. 176, 179.
499. Pitajaya—*Leptocereus quadricostatus* (Bello) B. & R. 252
500. Pitajaya—*Hylocereus trigonus* (Haw.) Safford.
501. Polisandre—*Staklia monosperma* (Tul) Urban. 171.
502. Pomarrosa—*Jambos jambos* (L.) Millsp.
503. Prenda de oro—*Pharus glaber* H. B. K.
504 Prieto—*Tabebuia heterophylla* (DC.) Britton. 693.
505 Pringa mosa—*Tragia volubilis* L.
506. Próspera—*Comocladia dodonaea* (L.) Urban 359, 360.
507 Quemadora—*Daphnopsis philippiana* K. & U 163, 363, 668.
508. Quiebra hacha—*Thyana striata* (Radlk.) Britton. 151, 269.
509. Quiebra hacha—*Allophylus occidentalis* (Sw.) Radlk. 444.
510. Quiebra hacha—*Eugenia pseudopsidium* Jacq.
511. Quiebra hacha—*Petesioides pendulum* (Urban) Britton. 317, 662.
512. Rabo de ratón—*Duggena hirsuta* (Jacq.) Britton. 400, 475, 616.
513. Rabo de ratón—*Casearia arborea* (L. C. Rich.) Urban. 651, 690.
514. Rabo de ratón—*Andropogon virgatus* Desr.
515. Rama menuda—*Myrcia splendens* (Sw.) DC.
516. Rama de perro—*Casearia sylvestris* Sw.—113, 550.
517. Ramoncillo—*Trichilia pallida* Sw 141, 237, 238.
518. Ramoncillo—*Trophis racemosa* (L.) Urb. 691.
519. Rasca garganta—*Philodendron krebsii* Schott.
520. Rasca garganta—*Parathesis serrulata* (Sw.) Mez. 554.
521. Retama—*Corynella pauciflora* DC.
522. Retama—*Chamaecrista portoricensis* (Urb.) C. & C.
523. Retamo—*Trichilia hirta* L. 97, 328, 409, 442, 656, 692.
524. Retama—*Sabinea florida* (Vahl.) DC.
525. Retama pricita—*Peiranisia polyphylla* (Jacq.) B. & R. 288.
526. Roble blanco—*Tabebuia rigida* Urban. 530.
527. Roble blanco—*Tabebuia pallida* Miers.
528. Roble colorado—*Tabebuia schumanniana* Urban.
529. Roble colorado—*Tabebuia haemantha* (Bert.) DC.
530. Roble de sierra—*Tabebuia rigida* Urban. 526.
531. Roble de guayo—*Bourreria succulenta* Jacq. 480.

532. Roble de guayo—*Bourreria domingueusis* (DC.) Griseb.
533. Rolón—*Pithecellobium unguis-cati* (L.) Mart. 217, 581.
534. Rosa de ciénaga—*Ginoria rohrii* (Vahl.) Koehn. 578.
535. Roseta—*Machaonia portoricensis* Baill.
536. Roseta—*Slonaea berteriana* Choisy. 99, 103, 415.
537. Royal poinciana—*Delonix regia* (Bejer) Raf. 227.
538. Rubia—*Zanthoxylum monophyllum* (Lam.) P. Wilson. 149, 385, 672.
539. Rubia—*Rubia persicifoliorum* Dunol.
540. Sabino—*Magnolia splendens* Urban.
541. Salvia—*Salvia splendens* Sellow.
542. Salvia.—*Pluchea purpuracens* (Sw.) DC.
543. San Bartolomé—*Sebestén ricksecheri* Millsp.) Britton.
544. Santa María—*Calophyllum antillanum* Britton. 181, 243, 391, 470.
545. Santa María—*Thespesia populnea* (L.) Soland. 645, 681.
546. Santa María—*Lantana involucrata* L. 145.
547. Santa María—*Osmia odorata* (L.) Sch Bip.
548. Santa María—*Vernonia albicaulis* Pers.
549. Sapote de costa—*Manilkara duplicata* (Sesse) Moc.) Dubard. 373.
550. Sarna de perro—*Casearia sylvestris* Sw. 113, 516.
551. Sebucán—*Cephalocereus royeni* (L.) B. & R. 204.
552. Sebucán—*Leptocereus quadricostatus* (Bello) B. & R. 499.
553. Sebucán—*Rheedia acuminata* (Spreng.) Tr. & Pl. 270.
554. Seca garganta—*Parathesis serrulata* (Sw.) Mez. 520.
555. Seplina—*Bauhinia monandra* Kurz. 228, 588.
556. Sereno—*Gundlachia corymbosa* (Urban) Britton.
557. Serrucho—*Mariscus jamaicensis* (Crantz.) Britton.
558. Sonajuelas—*Crotalaria retusa* L. 402.
559. Tabeiba—*Plumiera alba* L. 15, 167.
561. Tabeiba—*Maba sintenisii* K. & U. 273
562. Tabanuco—*Dacryodes excelsa* Vahl.
563. Tachuelo—*Pictetia aculeata* (Vahl.) Urban. 334.
564. Tamarindo cimarrón—*Acacia muricata* (L.) Willd.
565. Temporana—*Suriana maritima* L.
566. Teiporana—*Mallotonia gnaphalodes* (L.) Britton. 674, 696.
567. Terciopelo—*Heterotrichum cymosum* (Wendl.) Urban.
568. Terciopelo—*Clidemia strigillosa* (Sw.) DC.
569. Terciopelo—*Miconia racemosa* (Aubl.) DC.
570. Terciopelo—*Abutilon commutatum* Schuman.
571. Teta de burra cimarron—*Hirtella rugosa* Pers. 312.
572. Tibey parasítica—*Columnea tulae* Urban.
573. Tintillo—*Randia mitis* L. 96, 218, 459
574. Tortugo amarillo—*Sideroxylon foetidissimum* Jacq.
575. Tortugo prieto—*Ravenia Urbani* Engler.
576. Tuna brava—*Opuntia dillenii* (Ker. Gawl.) Haw.
577. Úcar—*Bucida buceras* L. 93.
578. Ucarillo—*Ginoria rohrii* (Vahl.) Koehn. 534.
579. Uña de gato—*Batocydia unguis* (L.) Mart. 347, 490.

580. Uña de gato.—*Martynia annua* L. 646.
581. Uña de gato—*Pithecellobium unguis-cati* (L.) Mart. 217, 533.
582. Uña de gato—*Pisonia aculeata* L. 214.
583. Uva de mar—*Coccolobis uvifera* (L.) Jacq. 584.
584. Uva de playa—*Coccolobis uvifera* (L.) Jacq. 583.
585. Uvillo—*Coccolobis laurifolia* Jacq. 195, 245, 653.
586. Uvillo—*Coccolobis portoricensis* (Urban) B. & S.
587. Varital—*Drypetes glauca* Vahl. 446.
588. Varital—*Bauhinia monandra* Kurz. 228, 555.
589. Varital—*Dipholis bellonis* Urban 695.
590. Ventura—*Ichthyomethia piscipula* (L.) Hitch.
591. Verdolaga—*Portulaca oleracea* L.
592. Verdolaga rosada—*Sesuvium portulacastrum* L. 620.
593. Verdolaga rosada—*Batis marítima* L. 54.
594. Verdolaguilla—*Pilea microphylla* (L.) Liebm. 356.
595. Verdolaguilla—*Pilea parietaria* (L.) Blume.
596. Víbora—*Angelonia angustifolia* Benth.
597. Víbora—*Dendropanax laurifolium* (E. March) Dcne, & Pl.
598. Viuda—*Distictis lactiflora* Benth 346, 436, 489.
599. Viuda—*Angelonia angustifolia* Benth.
600. Yaití—*Gymnanthes lucida* Sw.
601. Yerba de caña—*Lasiacis divaricata* (L.) Hitchc.
602. Yerba de ciénaga—*Aeschynomene sensitiva* Sw.
603. Yerba de clavo—*Centella asiatica* (L.) Urban
604. Yerba de clavo—*Jussiaea angustifolia* Lam.
605. Yerba de culebra—*Bramia monnieri* (L.) Drake.
606. Yerba de culebra—*Caconapea stricta* (Schrad) Britton.
607. Yerba de culebra—*Pilea nummulariaefolia* (Sw.) Wedd.
608. Yerba de culebra—*Mecardonia procumbens* (Milld.) Small.
609. Yerba linda—*Peperomia rotundifolia* (L.) H. B. K. 612.
610. Yerba maravilla—*Ruellia coccinea* (L.) Vahl. 670.
611. Yerba de medio real — *Peperomia magnoliaefolia* (Jacq.) A. Dietr.
612. Yerba de medio real — *Peperomia rotundifolia* (L.) H. B. K. 609.
613. Yerba de plata—*Rolandra fructicosa* (L.) Kuntz.
614. Yerba de papagayo—*Blechum blechum* (L.) Millsp.
615. Yerba de pollo—*Portulaca quadrifidia* L
616. Yerba pelada—*Duggena hirsuta* (Jacq.) Britton. 400, 475, 512.
617. Yerba de sal—*Philoxerus vermicularis* (L.) Nutt.
618. Yerba de sal—*Spartina patens* (Ait) Muhl.
619. Yerba de San Martín—*Sauvagesia erecta* L.
620. Yerba de vidrio—*Sesuvium portulacastrum* L. 591.
621. Zarza—(true)—*Acacia riparia* H. B. K.
622. Zarza—*Mimosa ceratonia* L.
623. Zarza—*Rubus rosaefolius* Smith. 236.
624. Zarzabacoa—*Chamaecrista diphylla* (L.) Greene. 658.
625. Zarzabacoa—*Meibonia purpurea* (Mill.) Vail. 665.
626. Zarzabacoa—*Meibomia supina* (Sw.) Britton.
627. Zarzabacoa enana—*Stylosanthes hamata* (L.) Taubert.

ADDITIONAL NAMES FOUND AFTER THE MANUSCRIPT HAD GONE TO PRESS

628. Allamanda—*Allamanda cathartica* L. 129, 640.
629. Amortiguado—*Margarita nobilis* L. 39, 654, 659.
630. Ausu—*Amomis caryophyllata* (Jacq.) K. & U. 365.
631. Basora prieta—*Waltheria americana* L. 371.
632. Bejuco de corrales—*Serjania polyphylla* (L.) Radlk. 61.
633. Bejuco de costa—*Ipomoea stolonifera* (Cyrill) Poir. 57.
634. Boislaglu—*Ficus laevigata* Vahl. 318, 326, 337.
635. Boton de cadeta—*Leonotis nepetaefolia* (L.) R. Br. 411, 688.
636. Caimito—*Chrysophyllum bicolor* Poir. 339.
637. Caña de castilla—*Gynerium sagittatum* (Aubl.) Beauv. 126 128.
638. Caña guava—*Arundo donax* L. 263.
639. Canelon—*Ocotea wrightii* (Meissn.) Mez. 131.
640. Cautiva—*Allamanda cathartica* L. 129, 628.
641. Caracolillo—*Phlebotaenia cowellii* Britton. 138, 140, 479.
642. Cedro hembra—*Turpinia paniculata* Vent. 37.
643. Cimarron—*Ocotea spathulata* Mez. 251, 421.
644. Coyure—*Bactris acanthophylla* Mart. 438.
645. Engaguilla—*Thespesia populnea* (L.) Soland. 545, 681.
646. Escorzonera—*Martynia annua* L. 580.
647. Espeiueto — *Krugiodendron ferreum* (Vahl.) Urban. 52, 223, 467.
648. Espejueto—*Scarcomphalus reticulatus* (Vahl.) Urban. 102.
649. Galán arboreo—*Acnistus arborescens* (L.) Schlecht 463.
651. Gia verde—*Casearia arborea* (L. C. Rich.) Urban. 513, 690.
652. Gitaran—*Dodonaea viscosa* Jacq. 159, 282.
653. Glateado—*Coccolobis laurifolia* Jacq. 245, 585, 653.
654. Gonglehout—*Margarita nobilis* L. 39, 629, 659.
655. Gru Gru—*Acrocomia aculeata* (Jacq.) Lodd 191, 254.
656. Guaita—*Trichilia hirta* L. 97, 328, 409, 442, 523, 656, 692.
657. Guayacán blanco—*Guaiacum sanctum* L. 276.
658. Hediondilla—*Chamaecrista diphylla* (L.) Greene. 624.
659. Higuillo millo—*Margarita nobilis* L. 39, 629, 654
660. Hincha—*Sapium laurocerasus* Desf. 342, 661.
661. Huevos—*Sapium laurocerasus* Desf. 342, 660.
662. Jacanillo—*Petiesioides pendulum* (Urban) Britton. 317, 511.
663. Javillo—*Hura crepitans* L. 410.
664. Juan caliente—*Rourea surinamensis* Meg. 62.
665. Junquillo—*Meibonia purpurea* (Mill) Vail. 625.
666. Kre Kre—*Tetrazygia eleagonoides* (Sw.) D. C. 156, 697.
667. Magüey—*Furcraea tuberosa* Ait. 174.
668. Majagua quemadora—*Daphnopsis philippiana* K. & U., 163, 363, 507.
669. Manto—*Acuan virgatum* (L.) Medic. 203.
670. Maravilla—*Ruellia coccinea* (L.) Vahl. 610.
671. Martin Avila—*Chione venosa* (Sw.) Urban. 445.
672. Mopurito—*Zanthoxylum monophyllum* (Lam.) P. Wilson. 149, 385, 538.
673. Muñeca—*Cordia nitidia* Vahl. 157.

674. Nigua de Playa—*Mallotonia gnaphalodes* (L.) Britton 566, 696.
675. Nuez moscada—*Octoea moschata* (Pavon) Mez. 422, 676, 677.
676. Nuez moscada cimarrona—*Octoea moschata* (Pavon) Mez. 422, 675, 677.
677. Nuez moscada del País—*Octoea moschata* (Pavon) Mez. 422, 475, 476.
678. Palo bobo—*Pisonia subcordata* Sw. 187, 189.
679. Palo de candela—*Myroxylon schuwaneckeaum* K. & U. 454.
680. Palo de gungulin—*Dendropanax laurifolium* (E. March) Dcne. & Pl. 248, 482.
681. Palo de jaqueca—*Thespesia populnea* (L.) Soland 545, 645.
682. Palo de Toro—*Faramea occidentalis* (L. A. Rich) 112.
683. Palo de vaca—*Trichilia triacantha* Urban 53.
684. Pascueta—*Leptilon pusillum* (Nutt) Britton. 433.
685. Pendulo blanco—*Vitex divaricata* Sw. 292.
686. Pensamiento de pobre—*Browallia americana* L. 389.
687. Pitangueira—*Eugenia lancea* Poir. 301.
688. Quina del paeto—*Leonotis nepetaefolia* (L.) R. Br. 411, 635.
689. Quisqual—*Quisqualis indica* L. 175.
690. Rabojunco—*Casearia arborea* (L. C. Rich) Urban. 513, 651.
691. Ramon—*Trophis racemosa* (L.) Urban. 518.
692. Retamo—*Trichilia hirta* L. 97, 328, 409, 442, 523, 656.
693. Roble prieto—*Tabebuia heterophylla* (D.C.) Britton. 504.
694. Romerillo—*Bidens pilosa* L. 388.
695. Tabloncillo—*Dipholis bellonis* Urban. 589.
696. Te del Mar—*Mallotonia gnapholode* (L.) Britton. 566, 674.
697. Verde seco—*Tetrazygia cleagnoides* (Sw.) D.C. 156, 666.
698. Zarza boba—*Anneslia portoricensis* Jacq. Britton. 180.

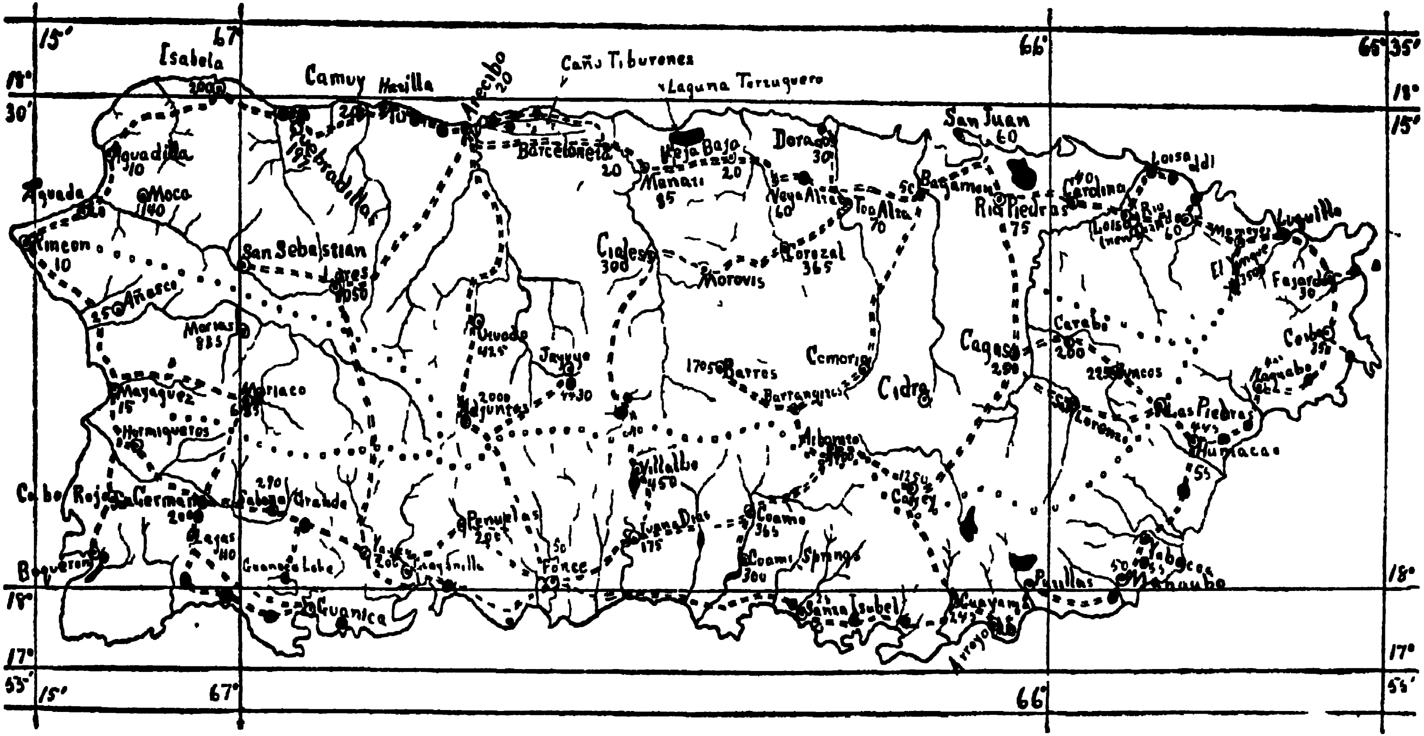

FIG. 1 —Map showing localities studied. The roads are indicated by =– and the stops by • . The crests of the mountain ranges are indicated by o o o o. The numbers refer to elevations in feet.

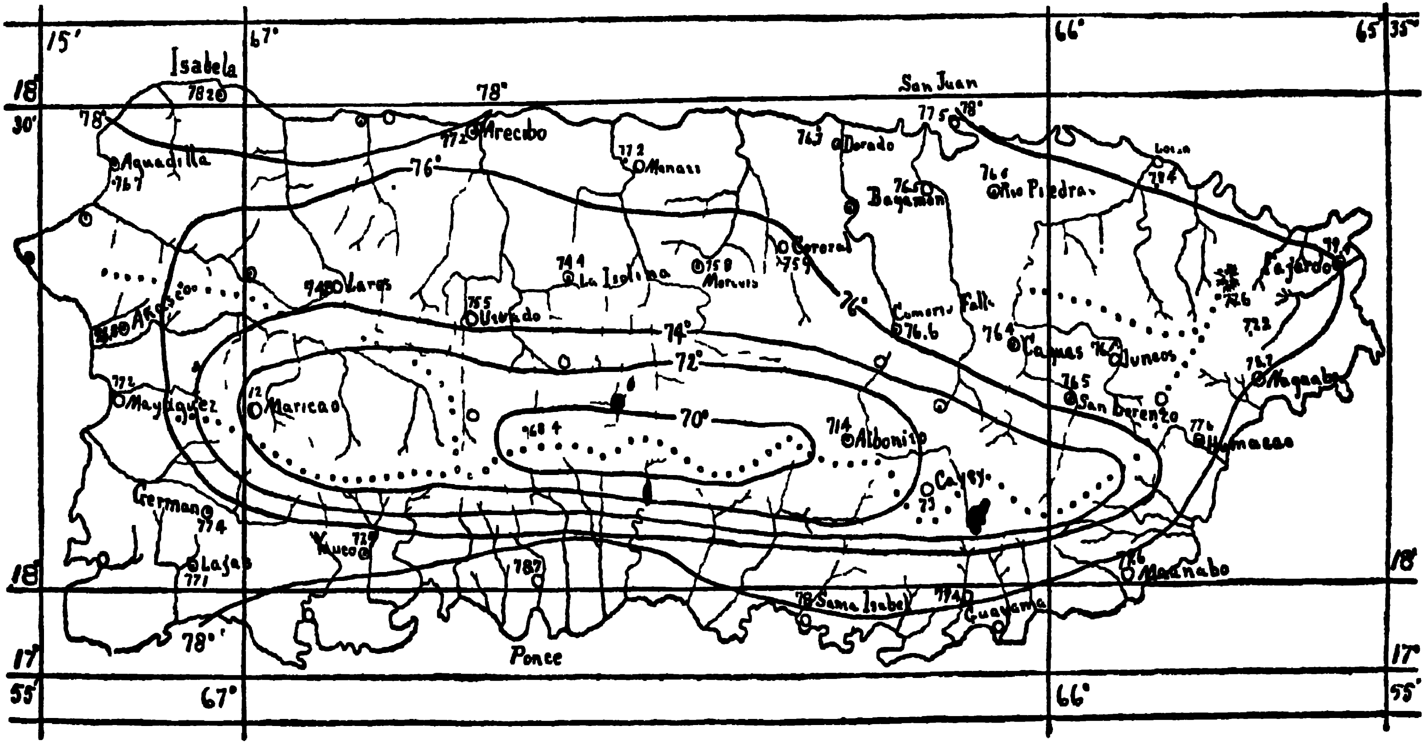

FIG. 2.—Map showing the average temperature for various altitudes on the island. Data obtained from the San Juan office of the U. S Weather Bureau.

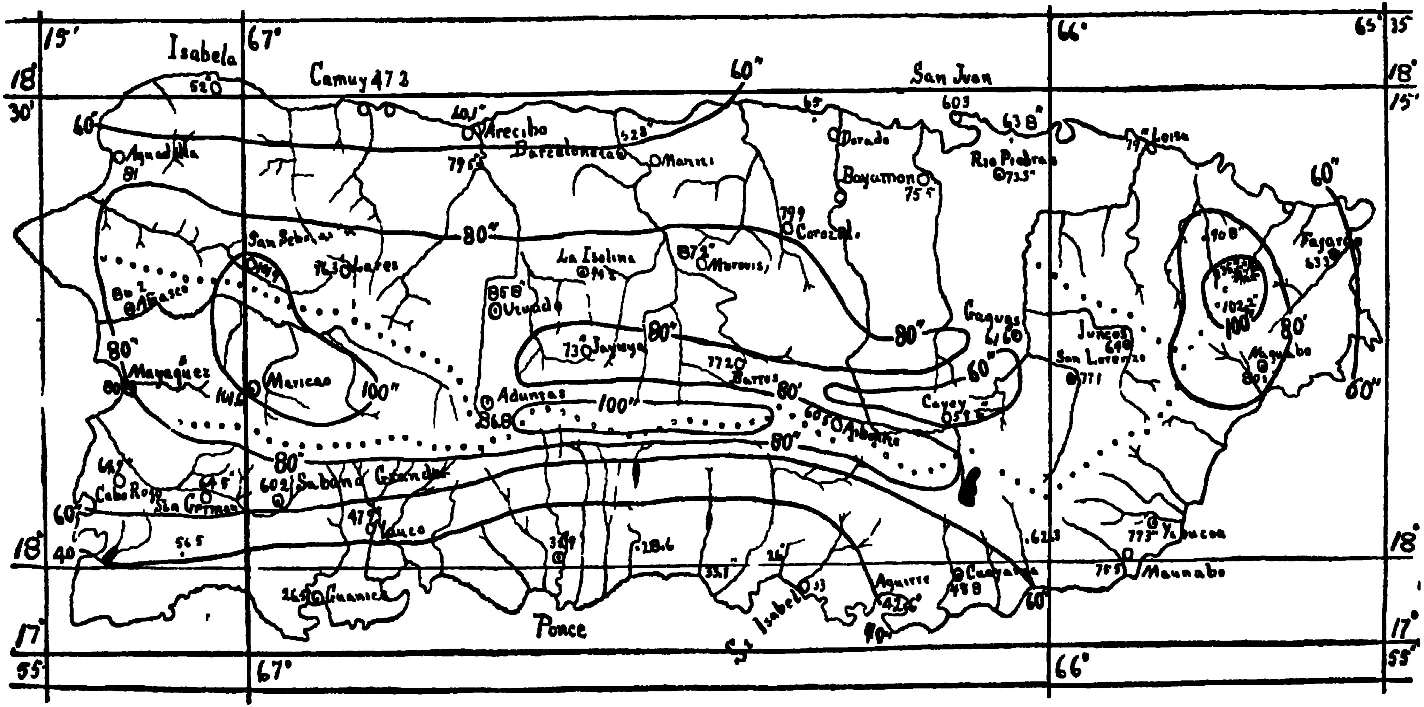

FIG. 3.—Map showing average rainfall in various parts of the island. Data obtained from the San Juan office of the U. S Weather Bureau.

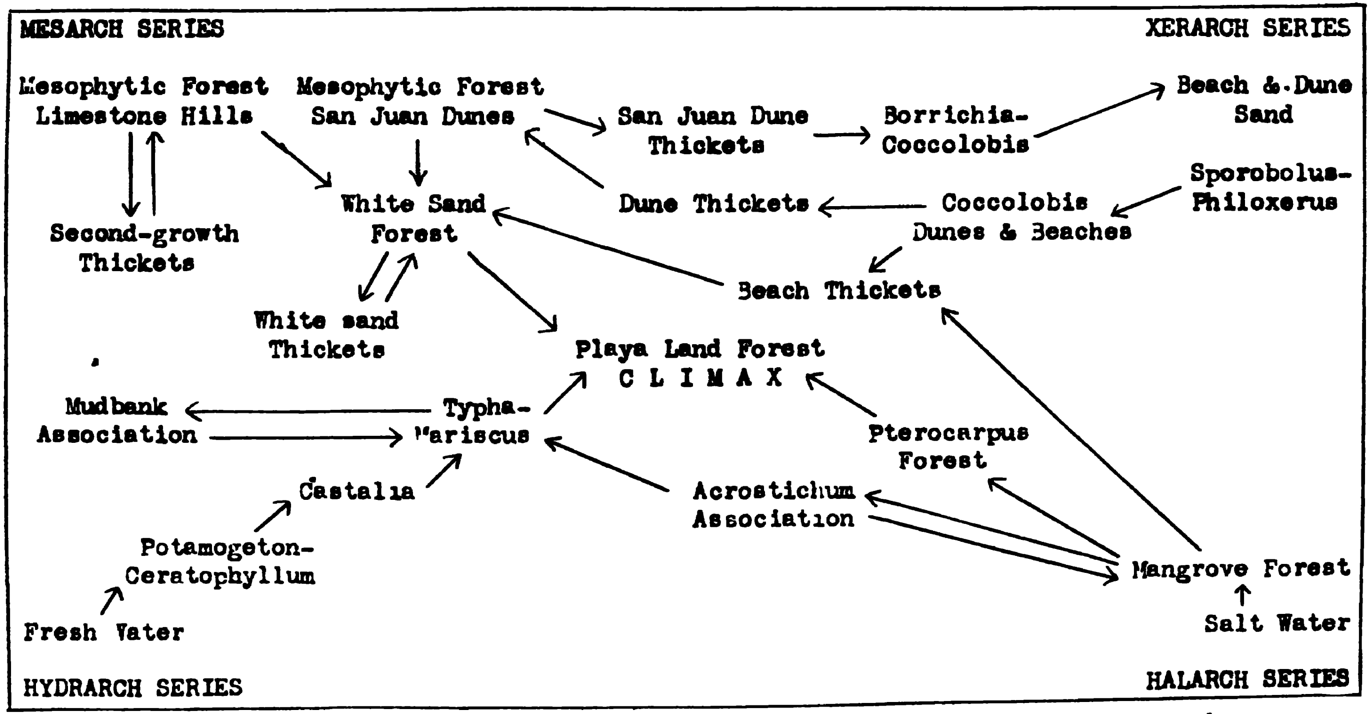

FIG. 4. The principal associations of the northern coastal plain of Porto Rico with their successional relations

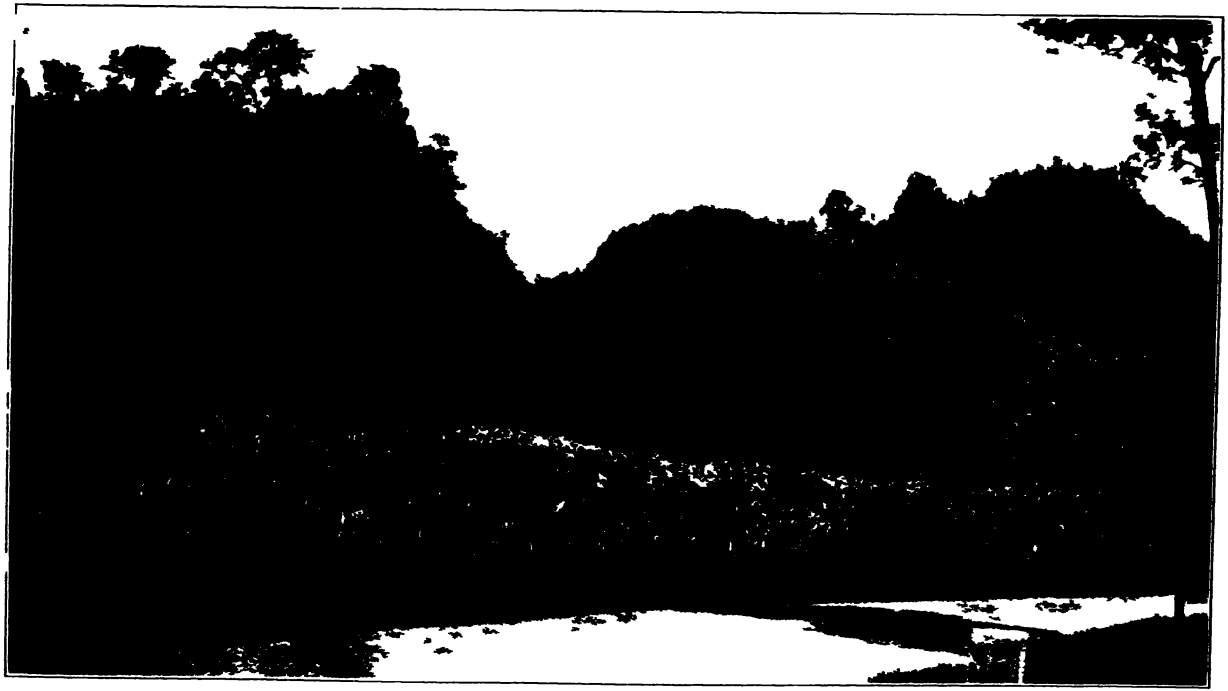

FIG 5 The mogotes or haystack hills The slender llume palms *Gaussia attenuata* are almost invisible Note the almacigo *Elaphrium simaruba* and the spreading leafy crowned jaguey *Ficus laevigata*

FIG. 6. Close view of a mogote or haystack hill. *Margaritaria nobilis* at the extreme left, the moco de pavo (*Anthurium acaule*) at the extreme right; *Ipomoea* sp. trailing over the rocks in the center. Other plants are *Piper amalago*, *Nectandra patens*, *Erythroxylon brevipes* and *Acalypha portoricensis*.

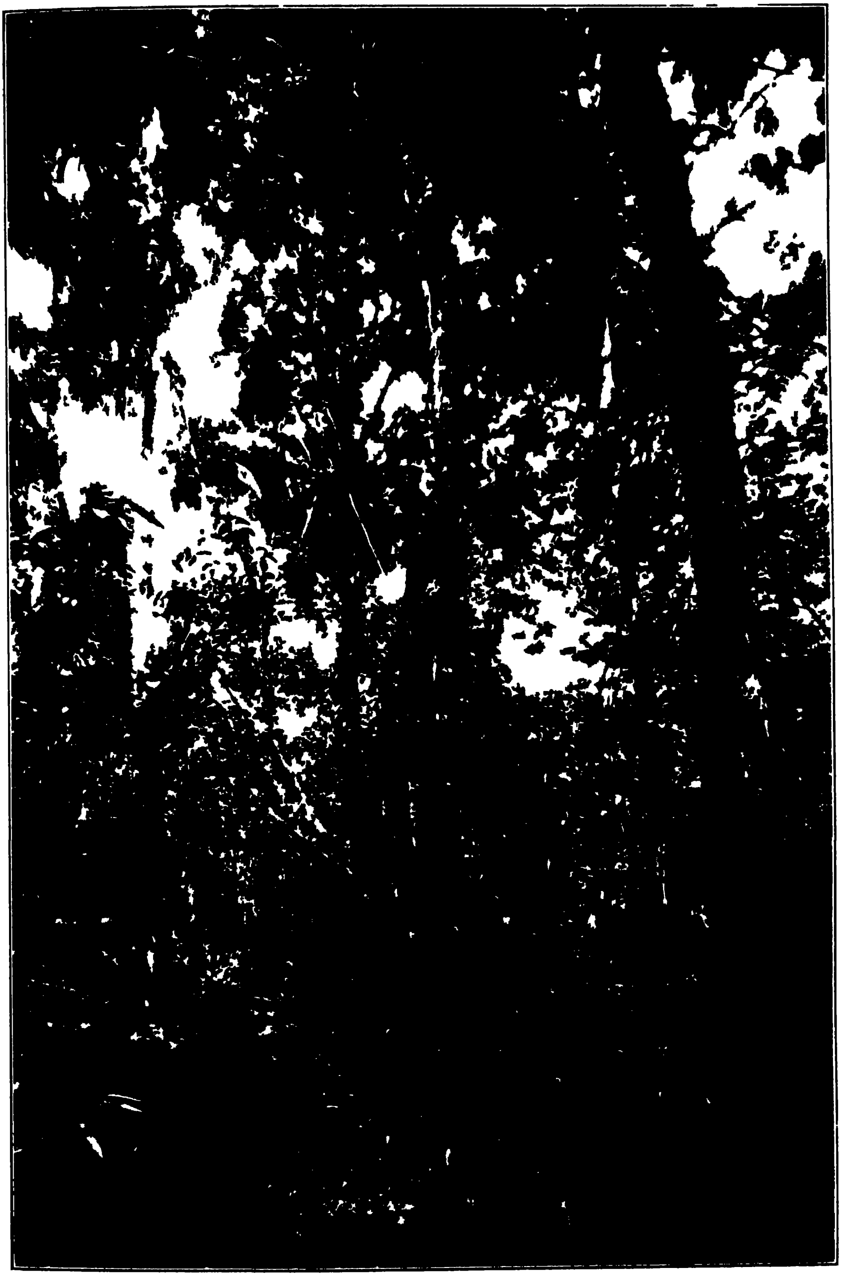

FIG. 7 White sand forest at Dorado The principal trees are the muñeca (*Dendropanax arboreum*), the María (*Calophyllum antillanum*) and the *Mammea americana*

FIG. 8. The white sand second growth thickets as seen at Laguna Tortuguero. These dense thickets are usually dominated by *Chrysobalanus icaco* but at this point the dominant is *Jambos jambos*.

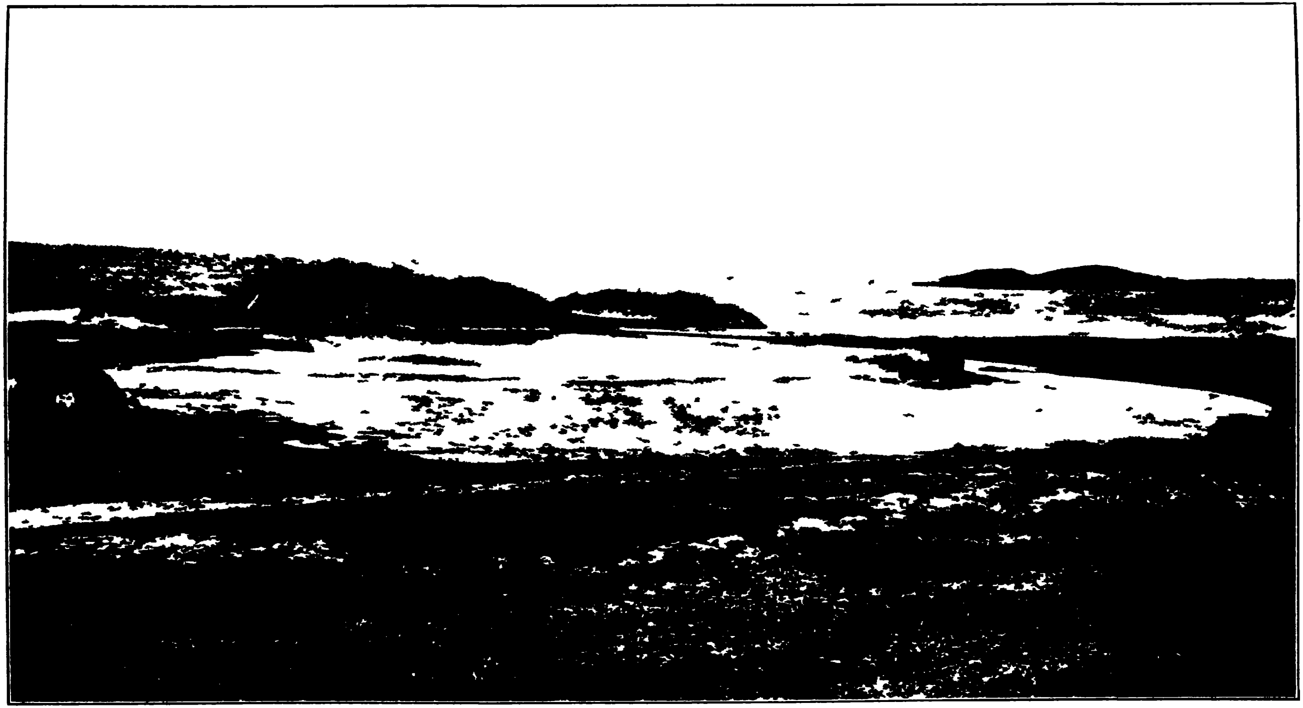

Fig. 9. Disintegration of the San Juan consolidated dunes. The sea has broken through and formed small semicircular bays on the landward side. Note the islands of this formation in the distance and the white patches of drifted shells in the fore ground.

Fig. 10. The yerba de sal (*Philoxerus vermicularis*) growing at the seaward margin of the dune vegetation, matojo de playa (*Sporobolus virginicus*) growing in the rear.

Fig. 11. Summit of a San Juan dune; the original vegetation has been reduced to a single wind swept thicket of uva de playa (*Coccolobis uvifera*) and a sod of *Stenotaphrum secundatum*.

FIG 12 Dune vegetation near Barceloneta This long dune is held by plant life consisting primarily of uva de playa (*Coccolobis uvifera*) Note the coconuts growing on the lee side

FIG 13 Effect of wind on dune vegetation The one sided tree (*Terminalia catappa*) is 5 meters high with a spread of 7 meters Note the tabeiba (*Plumeria alba*) in the rear and at the right and the maya (*Bromelia pinguin*) below

FIG. 14. Lee slope of an advancing dune west of Arecibo. The wind has broken through the series of dune thickets on the crest. The steep lee side is sparsely occupied by mato de la playa (Canavalia maritima), matojo de playa (Sporobolus virginicus) and yerba de sal (Philoxerus vermicularis) in the foreground.

FIG. 15. A break in the dune vegetation permits the sand to blow through and cover a railway.

FIG. 16. Seaward face of a consolidated San Juan dune west of Arecibo, showing the undercutting by the sea and the destructive power of the wave action.

FIG. 17. Disintegration of the consolidated San Juan dunes. Note the matojo de playa (*Sporobolus virginicus*) on the sand in the foreground, the temporana (*Suriana maritima*) on the top of the cliff at the left, and the low thicket of uva de playa (*Coccolobis uvifera*) in the rear.

Fig. 18. Low thickets of uva de playa (*C. uvifera*) on the San Juan consolidated dunes.

Fig. 19. Salt water pond on Icacos Cay surrounded by an interrupted fringe of common mangrove (*Rhizophora mangle*).

FIG. 20 Icacos Cay The limestone plateau is covered by a xerophytic chaparral in which caraquillo de Santa Maria (*Lantana involucrata*) is the dominant species

FIG. 21 Icacos Cay Palo bobo (*Pisonia subcordata*) is abundant along the wind swept crest of the ridge The vegetation is wind shorn and one sided.

FIG. 22. Icacos Cay. The vegetation of the wind swept ridge is xerophytic with several halophytic species. The single tall shrub is *Strumpfia maritima*.

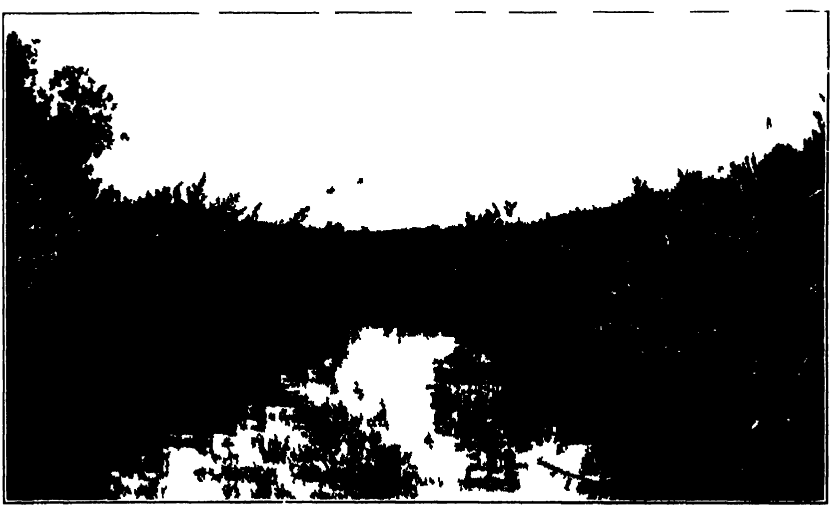

FIG. 23. Canal through the mangrove swamp of Caño Tiburones. Note the thicket of *Malache scabra* at the right and the ascending stems of *Drepanocarpus lunatus* at the left.

FIG. 24. Aquatic and shore vegetation, Laguna Tortuguero. The open water is occupied by cat-tails and Mariscus. A new colony of Mariscus is developing near the shore at the right. In the foreground a mud bank with scattered plants of *Bramia monnieri*. The shore thickets are dominated by *Chrysobalanus icaco* and *Ecastophyllum ecastophyllum*.

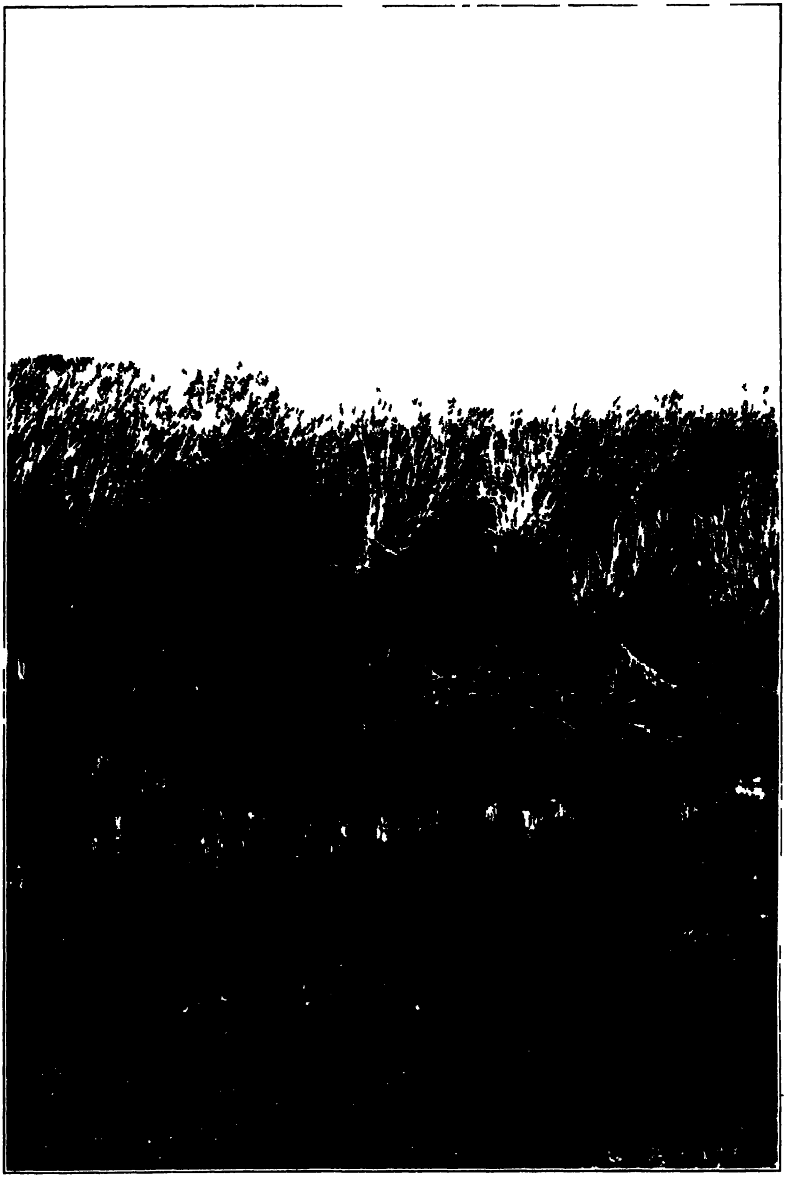

FIG. 25 Mud bank vegetation of Caño Tiburones This association is composed of *Bramia monnieri* and *Eleocharis* sp The Typha-Mariscus association forms the back ground.

FIG. 26. Mangrove vegetation east of Arecibo. Note the mangle blanco (*Laguncularia racemosa*) at the right, the tall mangle bobo (*Avicennia nitida*) in the center; and the common mangrove (*Rhizophora mangle*) in front.

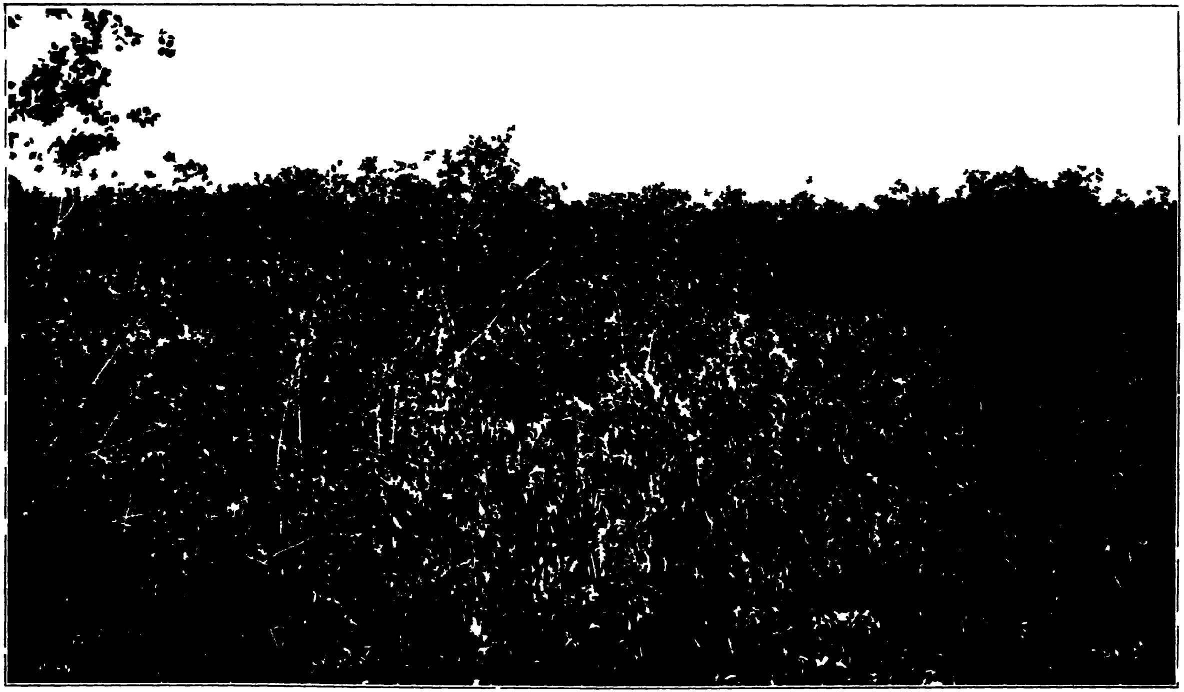

Fig 27 Acrostichum ferns and mangroves along road between Santurce and Bayamon The ferns form an almost pure colony in the foreground over an area from which the mangroves have been cut

FIG. 28. Marginal growth of tall ferns (*Acrostichum aureum*) on the border of the palo de pollo (*Pterocarpus officinalis*) association at Humacao Playa.

FIG. 29. *Pterocarpus officinalis* association, Humacao Playa. The trees in the foreground measure 5 meters across the buttress. Many bejuco de palma (*Paullinia pinnata*) hang from the trees.

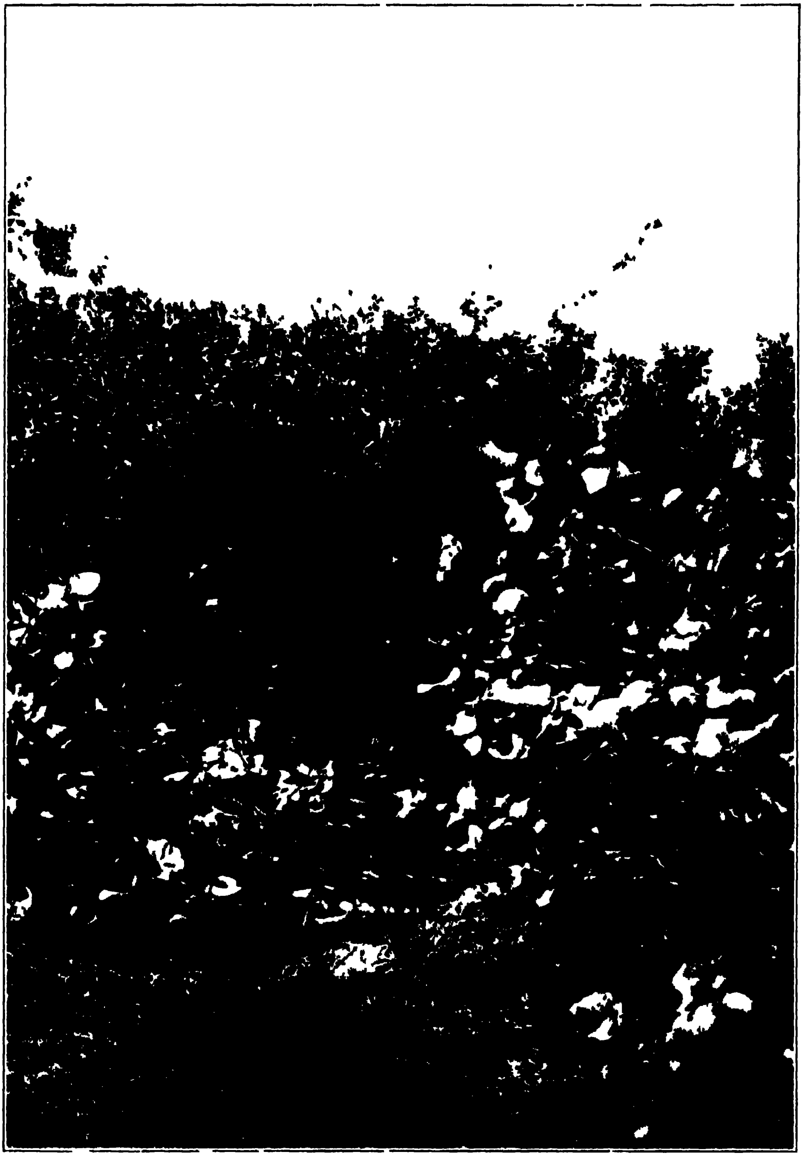

Fig. 30 Intermediate vegetation at Fajardo Playa. Note matojo de playa (*Sporobolus virginicus*) on the pastured foreground with uva de playa (*C. uvifera*) at the right. The thicket is composed of mangle boton (*Conocarpus erecta*). The ascending shrubs are escambron colorado (*Pithecellobium unguis-cati*).

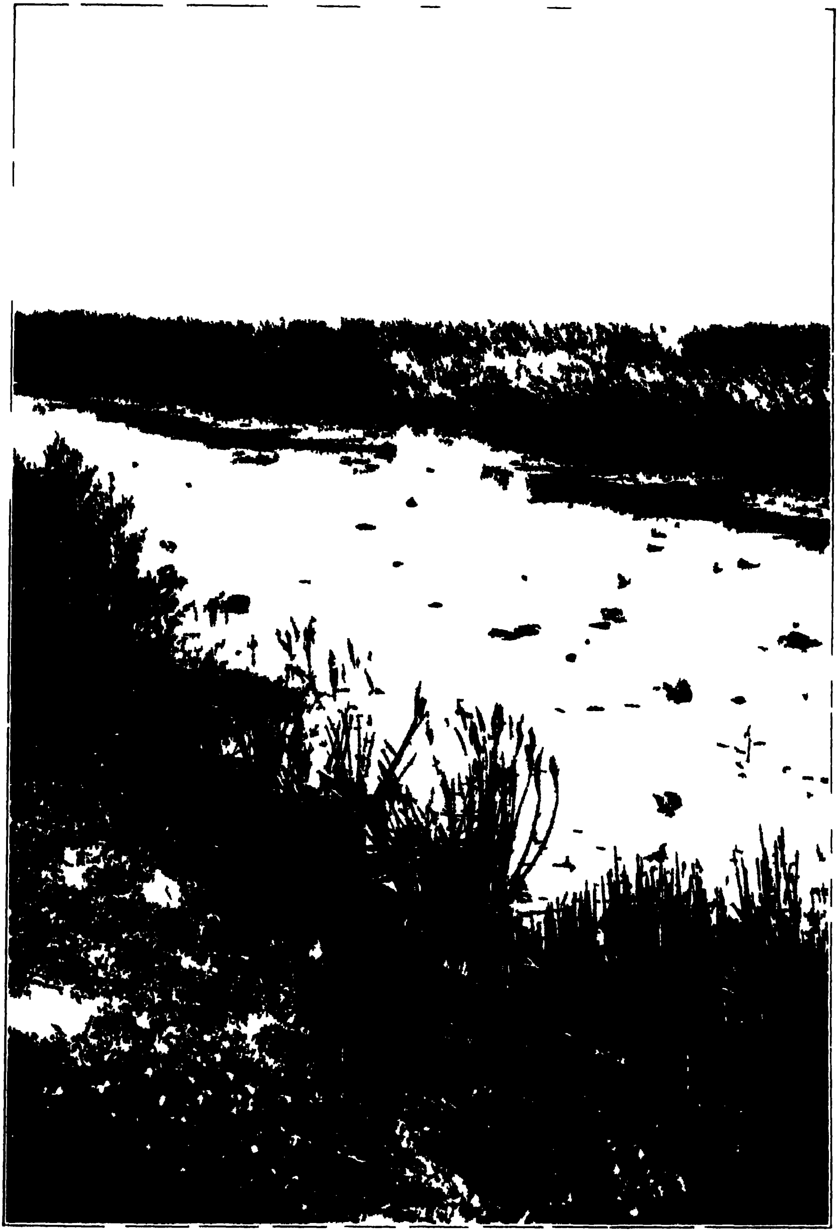

FIG. 31. Drainage canal in Caño Tiburones. Water surface covered with flor de agua (*Castalia ampla*). *Scirpus olneyi*, *Sagittaria lancifolia* and *Acrostichum aureum* along the bank from right to left. The Typha-Mariscus association in the back ground.

FIG. 32. Reversion of cane land to swamp, Caño Tiburones. Mats of *Bramia monnieri* in the central foreground followed by colonies of *Eleocharis* spp. Typha-Mariscus association in the rear.

FIG. 33. Roadside vegetation of the central mountain region. The common fern (*Dicranopteris bifida*) and llagrumo (*Cecropia peltata*) in the center. The common fern (*D. pectinata*) in the right foreground.

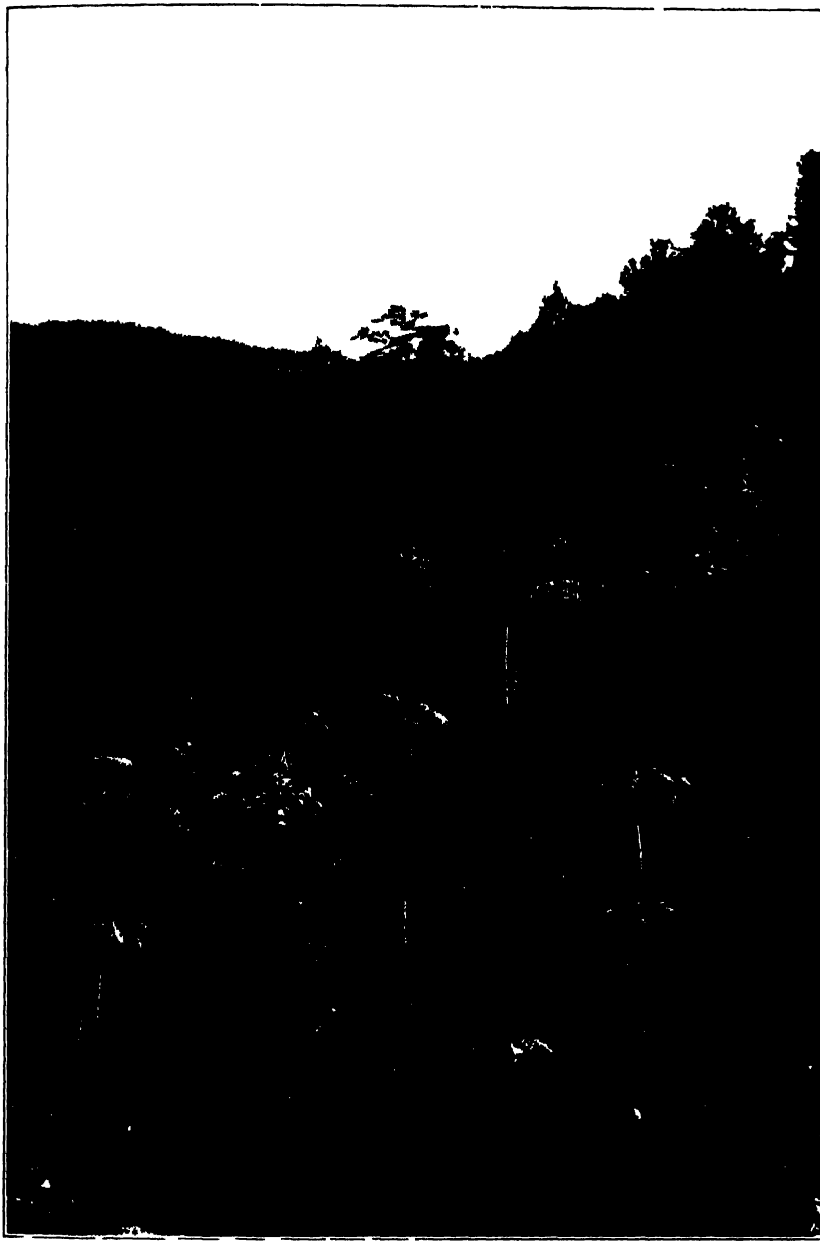

FIG. 34. Second growth forest in the central mountain region. The conspicuous trees are, the llagrumo (*Cecropia peltata*), the tree fern (*Cyathea pubescens*) and the llagrumo macho (*Didymopanax morototoni*).

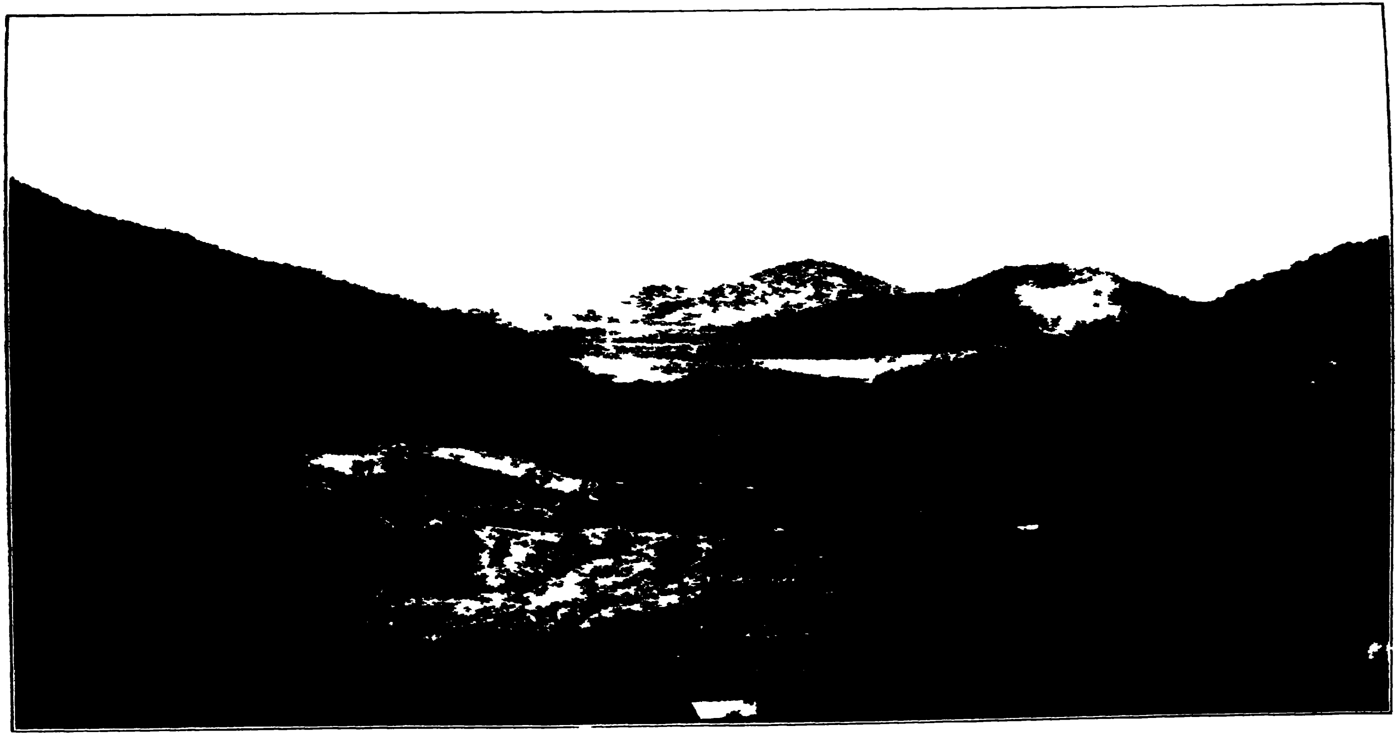

FIG 35 Mountain landscape north of Guayama looking southeast to the Caribbean Xerophytic grasslands extend far up the ridges and second growth mesophytic forests extend down the ravines The numerous scattered trees are mango (*Mangifera indica*) and jobo (*Spondias mombin*)

FIG. 36 Riparian vegetation at Naguabo Playa. The tidal river is bordered on the left by *Typha angustifolia* and other hydrophytes and on the right by the common mangrove (*Rhizophora mangle*) and by mangle bobo (*Avicennia nitida*).

FIG. 37. Roadside vegetation of the central mountain region south of Cayey, at an altitude of about 600 meters. *Peperomia glabella* in the central foreground; blooming plants of *Hillia parasitica* at left; long fronds of *Polypodium latum* in center with *Anthurium acaule* just above.

FIG. 38 Granadillo tree (*Buchonavia capitata*)

FIG. 39. Isolated tree of tabanuco (*Dacryodes excelsa*)

FIG. 40 Sierra palm forest, El Yunque Palms of various ages dominate the vegetation The ground flora is limited to palm seedlings and *Ruellia coccinea*

FIG. 41 Open place in sierra palm forest, El Yunque A colony of *Begonia decandra* occupies the center The trunks of the palms are covered with moss, juvenile plants of Marcgravia, and a few large Bromeliads

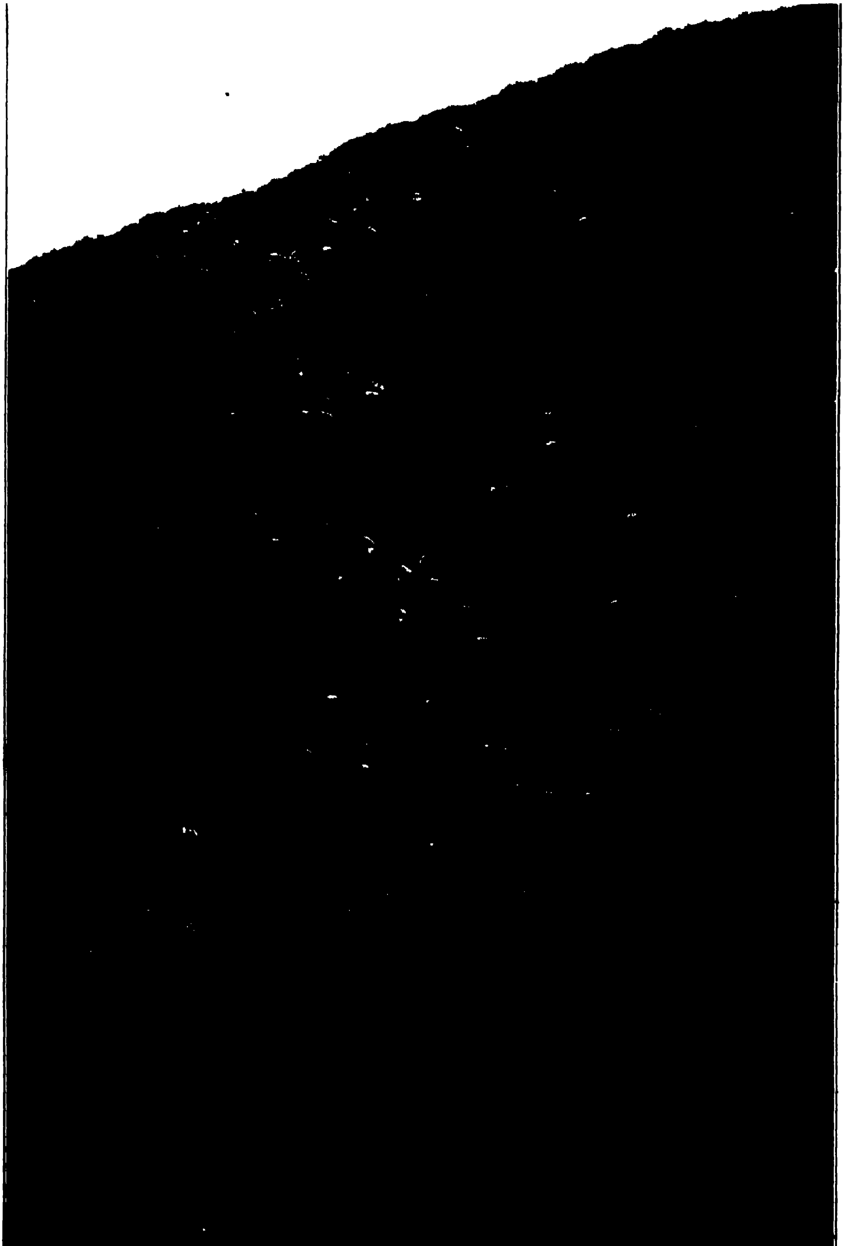

FIG 42 Forests of the upper slopes of El Yunque at an altitude of about 1050 meters The distribution of the sierra palms is in strips and patches and follows the contour of the land.

Fig. 43. Lower limit of mossy forest, El Yunque. Large trees about 10 meters high, epiphytic Bromeliads are conspicuous.

FIG. 44. Mossy forest along trail, El Yunque. *Ocotea spathulata* at upper left, *Tabebuia rigida* arching over the trail in the center, *Calycogonium squamulosum* at the right.

FIG. 45. Edge of mossy forest, summit of El Yunque. *Eugenia borinquensis* in the center; *Isachne angustifolia*, *Machaerina restioides* in the foreground.

FIG. 46 Interior of mossy forest, summit of El Yunque *Miconia pachyphylla* in central foreground and to left; *Tabebuia rigida* just back of center and to right.

FIG. 17. Interior of mossy forest summit of El Yunque. The principal trees are *Tabebuia rigida*, about 4 meters high and *Miconia foveolata* in the foreground.

Fig. 48 Edge of mossy forest promontory of El Yunque altitude about 1050 meters *Machaerina restioides* in the foreground, *Ceratostemma portoricensis* and *Lithostylidium sarmentosum* on the rock, the round-leaved shrubs are *Eugenia borinquensis*

Fig. 49 Thickets of the mossy forest association, summit of the lower peak of Cerro de la Punta, altitude about 1300 meters

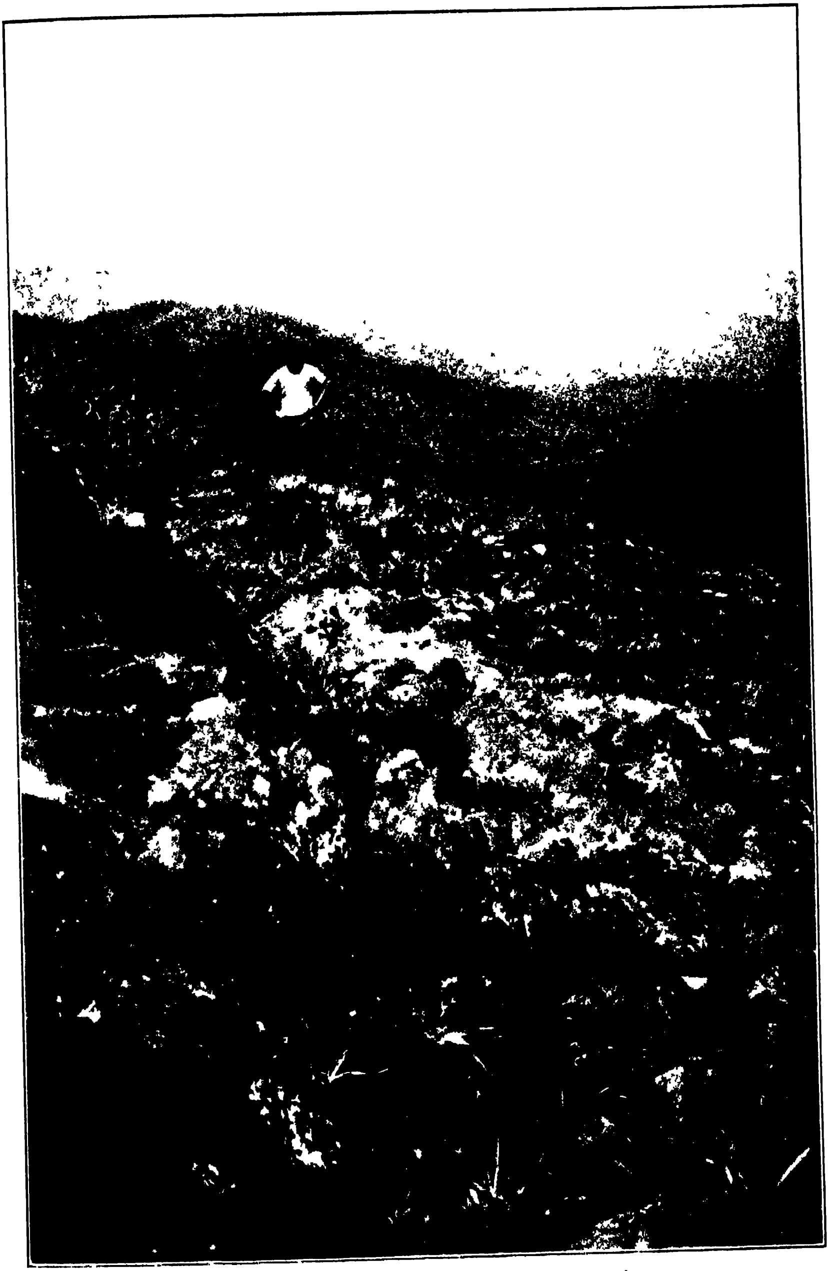

FIG. 50. Rock vegetation, summit of El Yunque *Machaerina restioides* conspicuous in central foreground, growing on mats of mosses with smaller plants of *Scleria*.

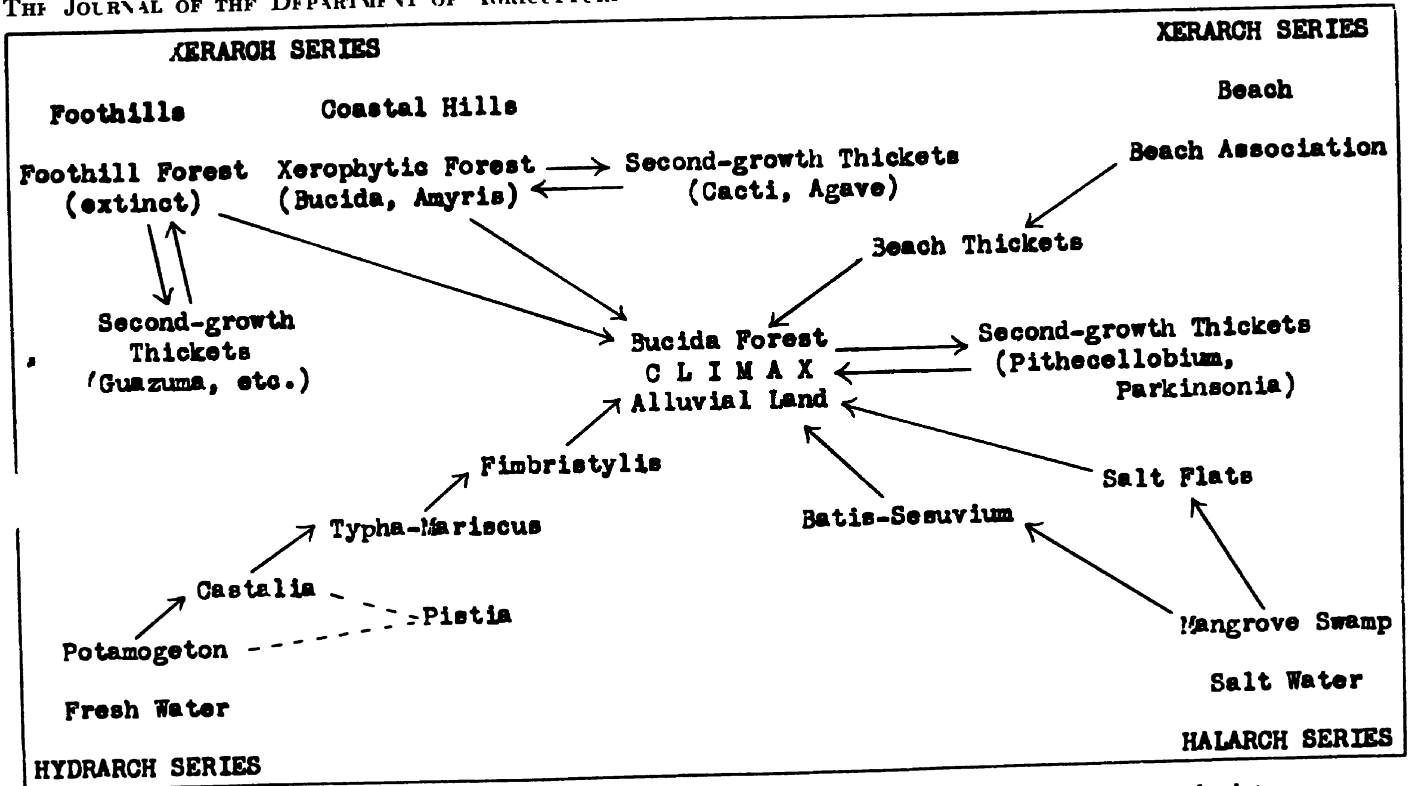

FIG. 51 The principal associations of the southern arid region of Porto Rico with their successional relations

FIG. 52. Salt flats west of Guanica. The nearly bare foreground is sparsely occupied by small isolated plants of *Batis maritima*, *Sesuvium portulacastrum*, *Portulaca quadrifida*, *Heliotropium curassavicum*, *Commicarpus scandens* and *Opuntia repens*. *Opuntia dillenii* growing in the rear.

Fig. 53. Salt flats west of Guanica. The colony of *Opuntia dillenii* on slightly higher ground is overrun and surrounded by *Batis maritima* and *Sesuvium portulacastrum*.

FIG 54 Salt flats Aguirre A loose sod of matojo de playa (*Sporobolus virginicus*) Also the shrubby mangle bobo (*Avicennia nitida*) and small colonies of barilla (*Batis maritima*) and verdolaga rosada (*Sesuvium portulacastrum*) The transition to the bucar forest (*Bucida buceras*) is shown in the background

FIG. 55. Nidos de gungulen (*Tillandsia recurvata*) growing on insulated electric wires, Santa Isabel.

FIG 56 Seaward margin of bucare forest (*B buceras*), Aguirre Mangle boton (*Conocarpus erecta*) at right, matojo de playa (*Sporobolus virginicus*) and horquetillo (*Chloris radiata*) in foreground Also mats of *Sesuvium portulacastrum* and *Heliotropium curassavicum* in the foreground

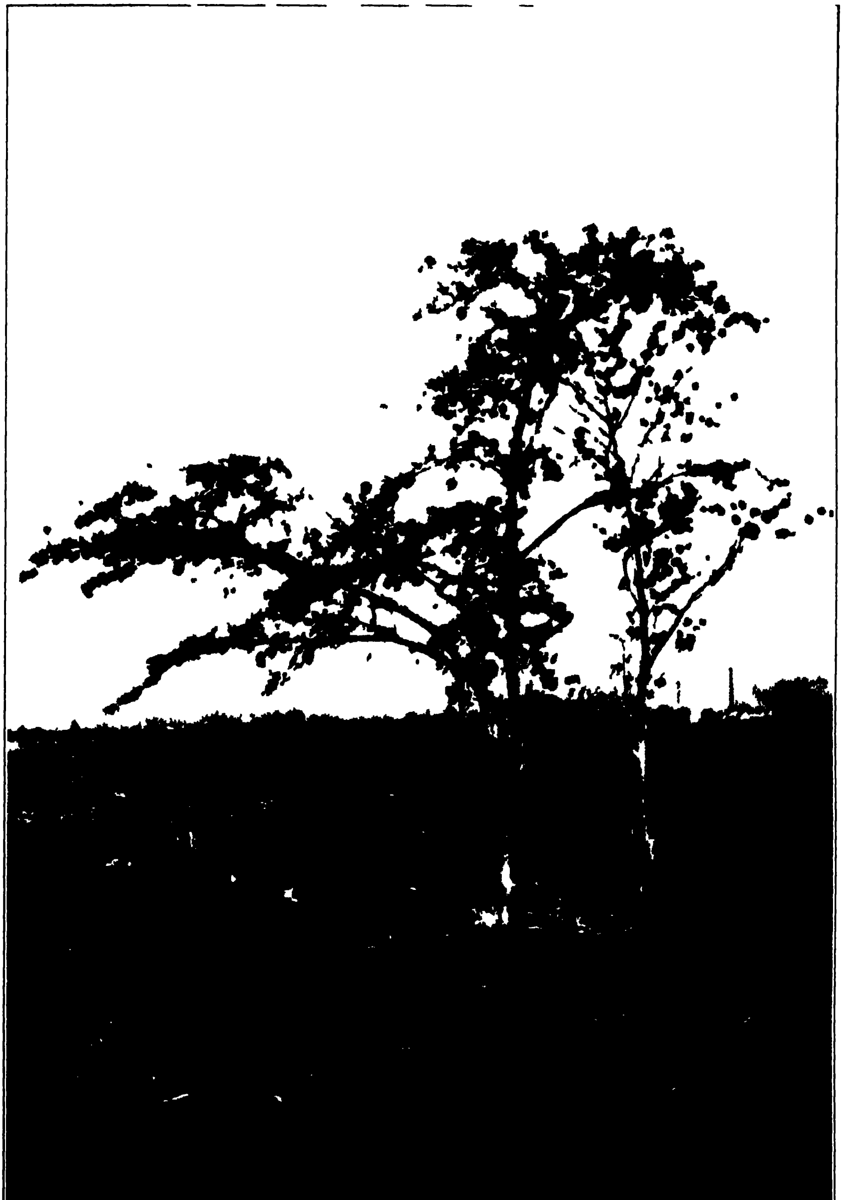

FIG. 57 Reversion of cleared pasture land to bucar forest (*B. buceras*) and thorn thicket near Ponce. The trees are heavily infested with nidos de gungulen (*Tillandsia recurvatum*). The thorn thicket is composed mostly of flor de Mayo (*Parkinsonia aculeata*) and escambron colorado (*Pithecellobium unguis-cati*) with various other species.

FIG. 58. Hydrophytic vegetation of the lagoon south of Lajas. The mud flats are occupied with masses of lechuguilla de agua (*Pistia stratiotes*) and flor de agua (*Castalia ampla*). The tall plants in the open water are eneas (*Typha angustifolia*).

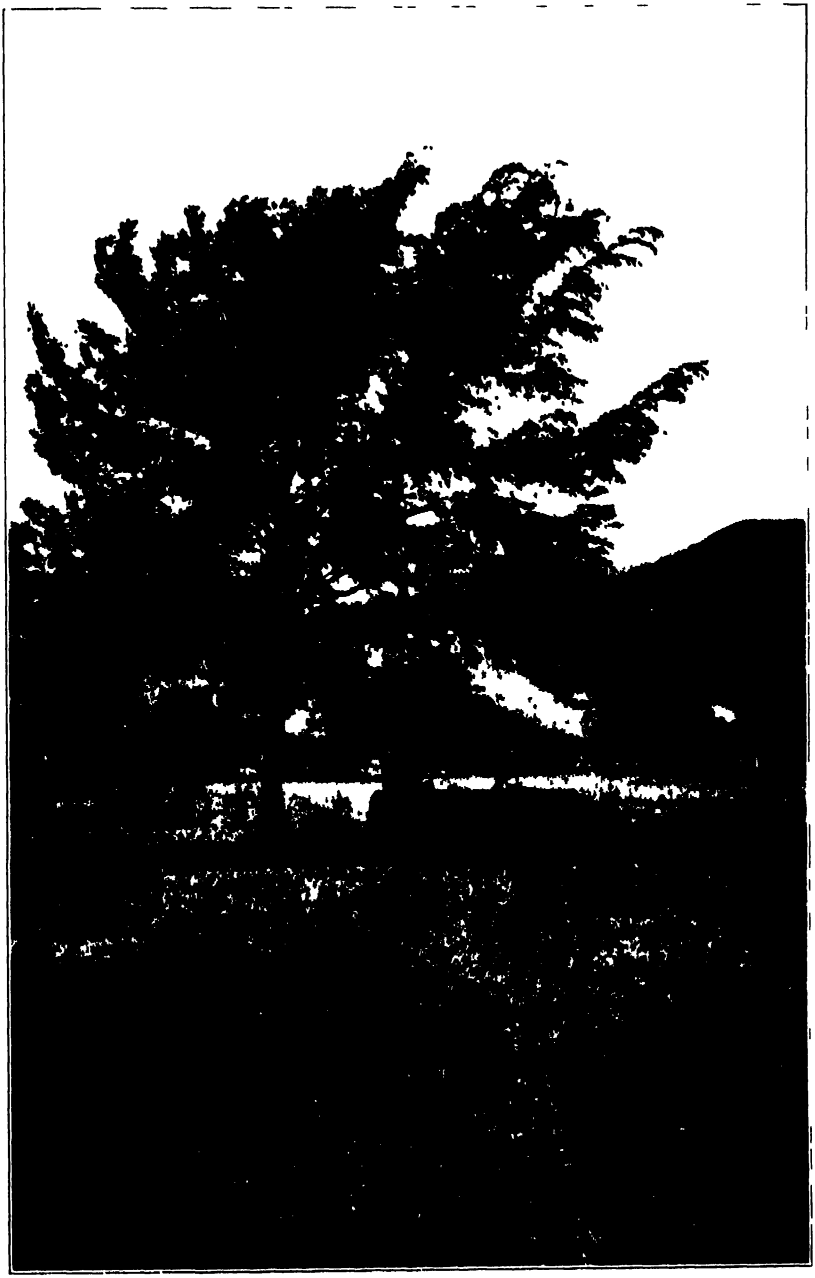

FIG. 59 A large bucar (*B. buceras*) tree in cleared pastured land south of Lajas

FIG. 60. Swamp vegetation near Aguirre. Four zones of vegetation are visible. The pastured foreground is occupied largely by *Cyperus laevigatus*, the next zone is *Fimbristylis spadicea*, the next is *Typha angustifolia* and the background is a mangrove forest.

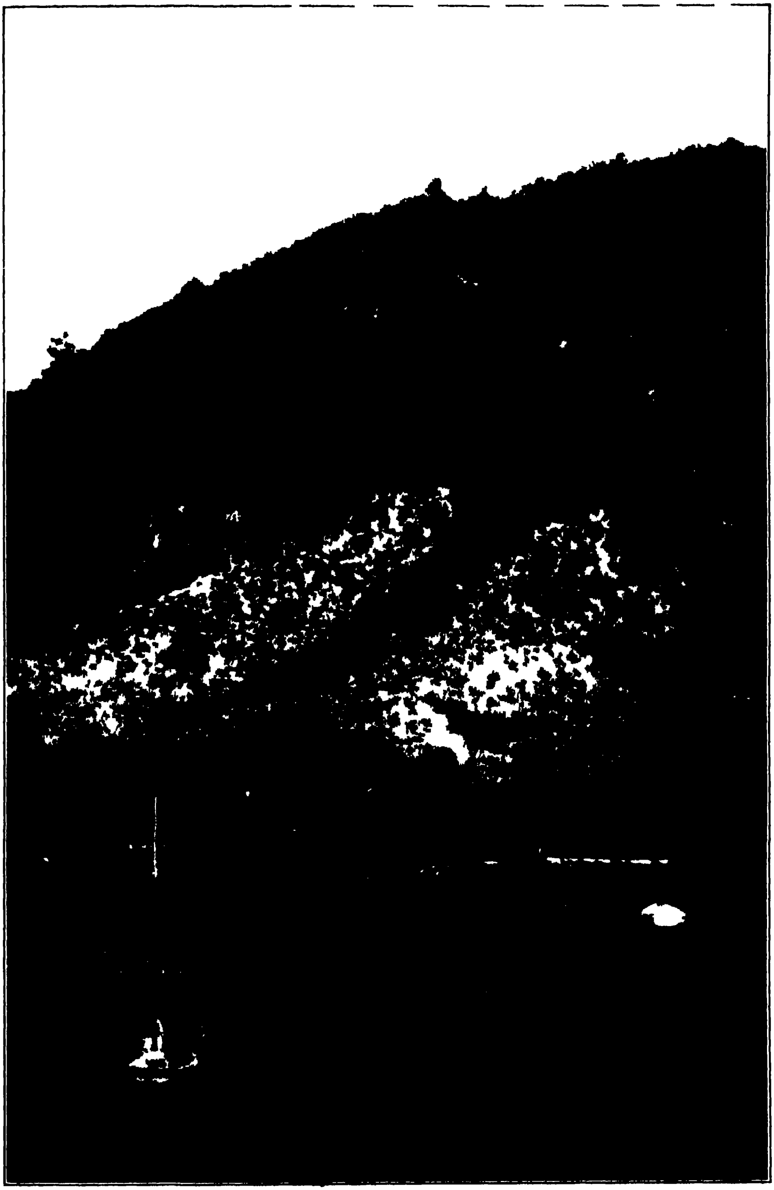

FIG. 61. Forest on Ponce limestone, east side of Guanica harbor. The xerophytic forest is composed of *Elaphrium simaruba*, *Amyris elemifera* and *Bucida buceras* and numerous other shrubs and small trees.

FIG 62 Partly cleared forest on shale hills, La Parguera *Amyris elemifera* in the center; *Eugenia rhombea* at right The rocky soil and absence of herbs is characteristic.

FIG. 63. Búcar tree (*Bucida buceras*) heavily infested with barbas de úcar (*Dendropogon usneoides*) near La Parguera

FIG 64 Serpentine hill west of Yauco Sebucan or dillo (*Cephalocereus royeni*) at the right, sebucan or pitajaga (*Leptocoreus quadricostatus*) at right and in center, small shrubs of *Pedilanthus angustifolius* in the right foreground and blooming plants of corita (*Agave missionum*) in the background

Fig. 65. Serpentine hill west of Yauco. Melon de costa (*Cactus intortus*) and corita (*Agave missionum*) in the foreground. Tall stems of *Plumiera alba* and leafless shrubs of *Andrachne cuneifolia* in the rear.

FIG. 66 Cape Mala Pascua, south of Maunabo The vegetation is entirely xerophytic The thickets on the summits are largely cotorra (*Ricinella ricinella*)

FIG. 67 Foothills of the central mountain range north of Yauco Traces of the xerophytic forests persist on the hill at the right Most of the land is in pasture with scattered mango trees (*Mangifera indica*) and jobo (*Spondias mombin*) and others

Fig. 68. Vegetation of San German limestone near San German. The llume palm (*Gaussia attenuata*) along the crest. Many almacigo trees (*Elaphrium simaruba*) covered with nidos de gungulen (*Tillandsia recurvata*).

FIG. 69 Vegetation of San German limestone near San German *Zamia portoricensis* in the right foreground, *Anthurium acaule* and *Clusia rosea* in center, *Clusia gundlachii* and *Tillandsia* sp at the top, with the vertical vines of *Serjania polyphylla* at the left

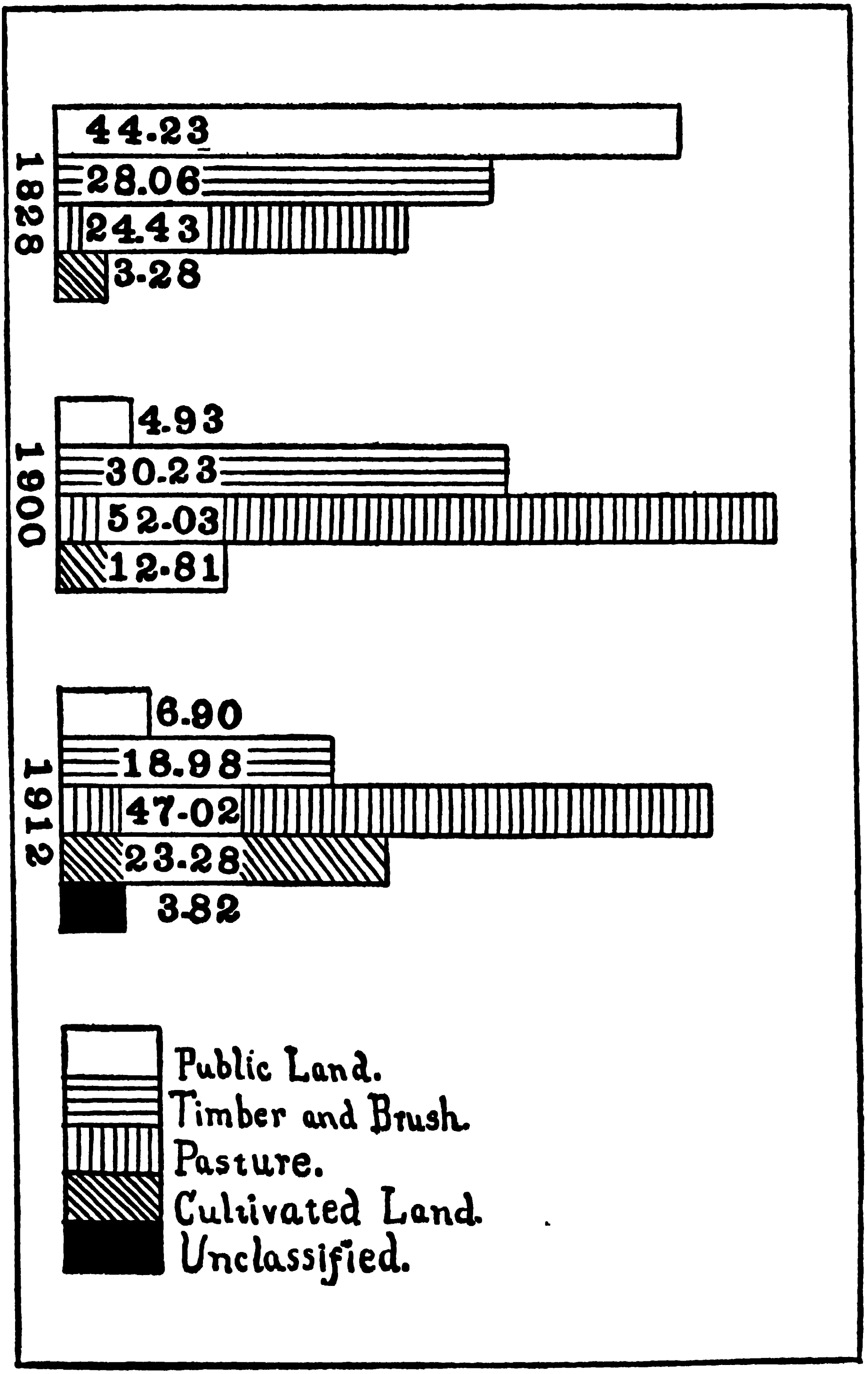

FIG. 70.—Showing the utilization of lands in Porto Rico. Adapted from Murphay.

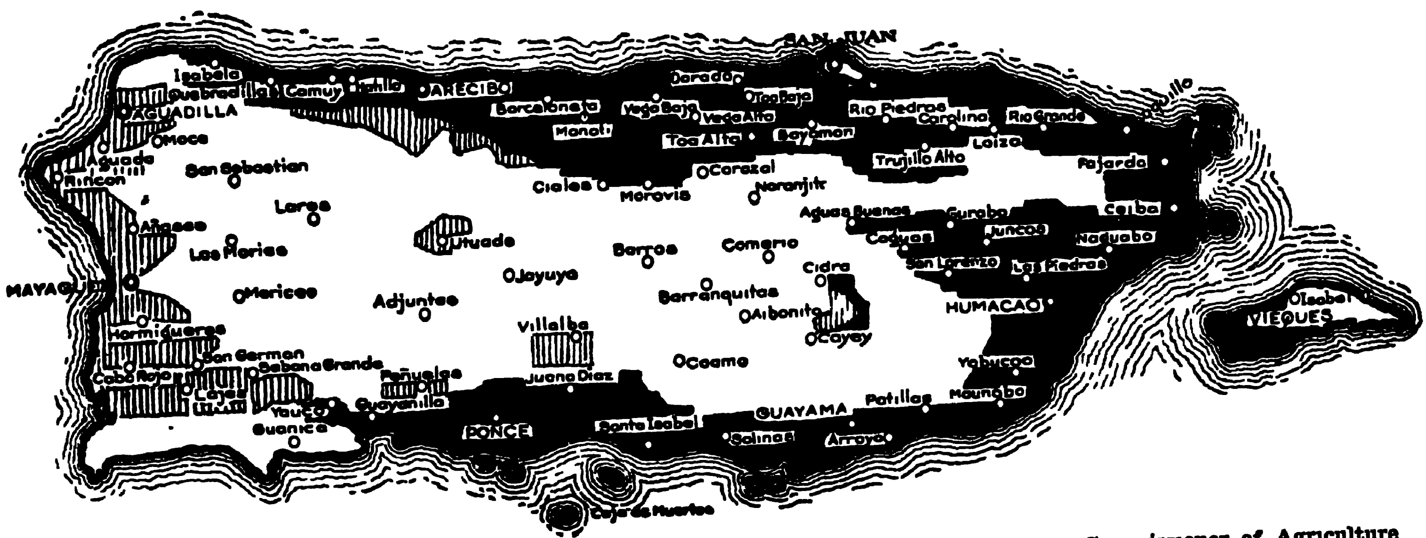

FIG. 71.—Showing the distribution of sugar cane. From the 1924–25 Annual Report of the Commissioner of Agriculture and Labor.

FIG 72 —Showing the distribution of coffee. From the 192 –25 Annual Report of the Commissioner of Agriculture and Labor

G. 73.—Showing distribution of the fruit industry. From the 1924–25 Annual Report of the Commissioner of Agriculture and Labor.

FIG. 74.—Showing the distribution of tobacco. From the 1924–25 Annual Report of the Commissioner of Agriculture and Labor.

FIG 75.—Showing the distribution of cotton From the 1 24–25 Annual Report of the Commissioner of Agriculture and Labor.

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MELVILLE T. COOK, Editor.

THE GUMMOSIS OF SUGAR CANE

MELVILLE T. COOK

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THE GUMMOSIS OF SUGAR CANE

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This disease was first found in Porto Rico in February, 1920 by Matz (**13, 14, 15**) who reported it from the neighborhood of Trujillo Alto, Río Piedras, Guaynabo, Las Piedras and Morovis. By January 1921 it had been reported from a much larger area including Caguas, Cidra, Cayey, Barros, Corozal, Aibonito and Barranquitas. In 1922 the disease was reported from Adjuntas, Isabela, Peñuelas, Guayanilla, Yauco, Humacao, Fajardo, Río Grande, Carolina and well to the west of Bayamón. Most of these points are in the eastern half of the Island. Matz (**1**) reports finding the disease on the oldest varieties grown on the island, such as Otaheiti, Rayada, Cristalina and Cavengerie or Colorado. The experiments and reports of Mr. Matz will be referred to later.

Mr. Matz left the Insular Experiment Station in 1922 and the writer took charge of the plant pathology laboratory in July 1923 which was too late to get records for that year. No severe attacks of the disease came to our attention until the spring of 1925 when a serious outbreak on the property of Central Columbia, Maunabo, was reported to Commissioner Chardon and the writer. Examination of the records of this Central showed a lowering of purities and other troubles over a period of about eight years which were probably due to this disease. The Cristalina which was grown most extensively on the properties of Central Columbia and vicinity was found to be severely infected. We recommended the substitution of BH-10 (12) and SC-12 (4) for the Cristalina which has resulted in the elimination of the troubles and an increase in sugar production. The Company very generously set aside one and one-half acres of good land for our use in testing varieties and have given us every possible assistance in this work. The planting and cultivation of these experimental plots was under the supervision of Mr. Francisco Ortiz.

GEOGRAPHICAL DISTRIBUTION

This disease has been definitely reported from New South Wales, Queensland, Fiji Island, Mauritius, Java, Borneo, New Guinea, Brazil, Colombia and St. Kitts of the British West Indies. A careful study of other cane growing regions of the world may show a much wider distribution. Some writers have expressed the opinion that the disease was in Cuba but these opinions appear to be without foundation.

HISTORY [1]

It appears that this disease was very severe in the province of Bahia, Brazil, as early as 1863 but the first published report was by Dränert (**9, 10**) in 1869. The disease, like many others, having been ascribed to insects, Dränert made some studies on this line with negative results. However, he did find several minute organisms in the diseased cane which he supposed to be the cause of the disease. Following Hallier's idea of polymorphism, he supposed all these organisms to be stages of a single species. His description of the symptoms and the yellow gum leaves very little doubt that this is the first authentic record of this disease.

The disease was next reported from Australia in 1893 by Cobb (**3, 4**) who was of the opinion that it had been in the country since 1876. The discovery of the disease in these two widely separated parts of the world is of special interest. He described the organism which he discovered under the name of *Bacillus vascularum*. He conducted many successful inocculation experiments but did not use pure cultures. However, there is no doubt as to the authenticity of his records and the disease is frequently referred to as "Cobb's disease of Sugar Cane".

In 1894 the disease was again reported from Brazil (**17**) but was much less severe than in 1869 which was supposed to be due to the growing of more resistant varieties. This attack was on Otaheiti (known in Brazil as Cayanna) which we now know to be one of the most susceptible varieties. We have no very definite information as to the resistant varieties grown at that time.

In this same year the disease was reported from Mauritius by Bonâme (**1**) as common on La Canne Bambou.

Extensive studies were made in Australia during the next few years by Cobb (**6**), Tryon, (**22**) and R. Greig Smith (**18, 19**) which added to our knowledge of the subject.

[1] The facts concerning the history of this disease are drawn largely from Smith's Bacteria in Relation to Plant Diseases (21).

Dr. Erwin F. Smith published a short paper (20) in 1904 but nothing more appears to have been done until this same author published the results of a very comprehensive study (21) of the disease in 1914.

This was followed by studies in the Dutch Indies by Groenewege (11, 12) and Wilbrink (23) from 1915 to 1920.

The next studies were made by Matz (13, 14, 15) in Porto Rico in 1920 and 1921.

The disease was found in St. Kitts of the British West Indies in 1925 (26).

The last publication which has come to the attention of the writer was by Chardon (2) who found the disease in Colombia, South America in 1926.

ORIGIN AND SPREAD OF THE DISEASE

It is frequently very difficult to trace a disease to its origin. The sugar cane like many other of our important crop plants is a product of Asia. In its migrations to other parts of the world it has no doubt carried many of its diseases and has probably contracted other diseases from related plants in the course of its wanderings. Although we do not know where the disease originated, it is interesting to note that the first three reports of this disease were from three distant parts of the world, Brazil, Australia and Mauritius. It is improbable that the disease originated independently in these three distant places. North (16) is of the opinion that the disease was brought to Australia from Brazil or Mauritius. The geographical study of this disease is further complicated by its behavior in the field. The first report from Brazil in 1869 indicated that the disease had been in the country at least six years previous to the report. Cobb's first report from Australia in 1893 indicates that it had probably been in the country for seventeen years previous to that date. Cobb also states that the symptoms were much more pronounced on plant than on rattoon cane. North states that the disease sometimes disappears from localities where it had been very severe.

Matz comments on the sudden appearance of the disease in Porto Rico as follows: "From the sudden appearance of gumming disease here in the fields, where no new seed introductions were made for some time and in varieties which have been grown here for many years, no definite opinion could be formed as to its future possible spread, but now it is certain that it is spreading rapidly and that it is becoming a general epidemic." The wide distribution of the

disease in Porto Rico justified this statement by Matz but the very few reports during the next two years indicated that if the disease was present that it was in such small quantity as not to attract the attention of either the growers or the mill men. During this time many suspicious pieces of cane were sent to the writer for examination but only a very few proved to be infected with the gum disease organism. In fact the only locality in which the disease persisted in quantity was the vicinity of Fajardo and even there it was greatly reduced.

In the spring of 1925, the writer and Hon. C. E. Chardon, Commissioner of Agriculture, were called to Central Columbia at Maunabo where we found a severe outbreak of gummosis on Cristalina and Rayada, the two most important varities grown in that immediate vicinity. A study of the mill records showed more or less lowering of purities over a period of about eight years which may have been due to this disease. Acting upon recommendations the owners of the properties on which the disease was present we started a campaign for the elimination of the Cristalina and Rayada and the planting of BH-10 (12 and SC-12) (4).* In 1928 this Central reported the largest production of sugar in its history from a smaller acreage.

These results from the two Colonias from which this Central drew the largest amount of its cane may be summarized as follows:

	1924-25	1925-26	1926-27	1927-28
Percentage of infection	37.8 36.8	2.0 3 5	12.4 16.	8
Rainfall inches	85.19	62.00	71.35	77.93
Total acreage	1056.63	825.71	750.00	769.56
Cane tonnage	30500.00	18664 00	25519.30	36188.99
Bags Sugar	48544.00	56544.00	41589.00	75894.00

Reports over 1925 to 1927 indicated small infections of the disease from Santa Isabel on the west to Fajardo on the east, but no severe outbreaks were reported. In 1928 the disease was reported from Fajardo and Santa Isabel and the symptoms were found on two seedlings in a field test west of Ponce. A study of the field test (page 167) Central Columbia showed a decided decrease in the amount of infection the second year as compared with the first year. This is in harmony with reports from other parts of the world. The writer has no explanation for the sudden appearance of the disease in Porto Rico or for its fluctuations in Porto Rico and other places.

Some doubt exists as to whether the disease is the same in the

various countries from which it has been reported, especially the form appearing in Java. The form appearing in Java does not produce gum as in the case of other countries. The writer agrees with Wilbrink that a comparative study of the two forms of the disease must be made before this point can be determined.

Cultures of *B. vascularum* were sent to Dr. M. C. Goldsworthy of the University of California for comparison with cultures from Australia. He replied as follows:

BERKELEY, CALIFORNIA, *June 27, 1927.*

DR. MEL. T. COOK,
Insular Experiment Station,
Río Piedras, P. R.

DEAR DR. COOK:

I have now your *Vascularum* Cultures. They arrived about a month ago, to be exact on the 24th of May. The cultures were in excellent shape, excepting Nos. 5 and 6. I have tried everything to invigorate them but to no avail. Your *vascularum* types are different than those that we have received from Australia. That is they behave differently on media. So far I have had no opportunity of comparing the cultures by the serological method.

In am expecting cultures of *B. stewarti* and *Ps. campestris* from the type culture collection at Washington to compare with your types and with other yellow organisms.

Hoping that you will not become impatient for results and thanking you for your kind assistance in getting these valuable *vascularum* cultures I remain,

Very truly,

(signed) M. C. GOLDSWORTHY,
Research Assistant.

Unfortunately were not able to follow this comparison of cultures which leaves us in doubt as to whether the Porto Rico organism is exactly the same as the one found in Australia.

SYMPTOMS.

The first reasonably authentic description of the disease was given by Cobb and is as follows:

"When a cane crop is gummed it presents a variety of symptoms that vary according to the severity of the disease. When only slightly gummed the crop appears to be in a fair condition. Here,

and there, however will be seen stools containing one or more stalks with dead tops. The base of the arrow (terminal shoot or flower-stalk) in such cases will be found to be rotten, and usually one or more cavities of considerable size are to be seen near the top of the stalk, filled or partially filled, with offensive matter. At first one is inclined to attribute these cavities to the inroads of grubs or borers. This idea is soon seen to be mistaken, for there is no entrance or outlet to the cavity, nor are there any traces of excrement, both which facts prove conclusively that the cause lies in some other direction. The tissue about these cavities is generally brown, black, or dark red in color, and reeking with a slimy offensive substance which varies from nearly colorless, through yellow, to brown. Plants whose tops have died from gumming often shoot from buds half way down, but this symptom is not peculiar to gumming. It occurs also in plants nipped by frost or by borers".

"If a stock which has died at the top in the manner described be cut into pieces with a very sharp knife, in such a manner as to leave the cut surface quite smooth, a honey-colored gummy matter will, in a few minutes, be seen to ooze slowly out and form in droplets on the end of the cut fibers. This gum is sometimes nearly transparent, sometimes rather opaque, and varies also in color from nearly colorless into various tints of yellow according to the stage reached by the disease. This gummy matter is usually more abundant near the top of the stalk than the near the bottom, or at least oozes out more freely. In the course of an hour or thereabouts these droplets of gum become so large as to run together and form large drops, and if two or three dozen cuttings from badly diseased stalks be laid in a closely covered box over night one may in the morning collect from their ends a teaspoonful of yellow mucilaginous gum."

"The gum which thus oozes out in such quantities, if allowed to do so, at last becomes dry, owing to the evaporation of its water. In this state it appears as bright yellow stains on the end of the cutting. Sometimes the gum oozes out in a state so nearly dry that it hardens as it issues from the fibers into a yellow, coiled-up, hair-like body, and inasmuch as each fiber gives rise to one such body, all the fibers together originate a yellow mossy appearance on the end of the cutting."

"If another stalk, which is apparently sound, be taken from a stool in which one or more stalks have been already blighted by gumming, as above described, such stock will be found to exhibit the same symptoms, except that the cavities and rottenness at the base

of the arrow are wanting. Moreover, if other stalks be removed from shoots of cane standing nearby in the same field, but which as yet, show no outward symptoms of this disease, the chances are that some of them will also be found to be more or less gummed."

"In some cases the amount of gum is so small as to ooze out in but a trifling quantity, to be detected only with a magnifying glass. Finally, the quantity of gum may be so small as not to ooze out at all; in such cases a good microscope is necessary to demonstrate that the gum is present."

"After the cane is cut and ready for the mill, gummed stalks can be recognized not only by the yellow dried-up gum that exists on the cut ends, but also by their color. Gummed stalks generally have an over-ripe appearance. Green and yellow canes, when badly gummed become yellowish or orange, or even somewhat purple in color. The ribbon canes show similar alterations in their yellow stripes while their purple or black stripes tend to take on a reddish cast. The waxy bloom, usually to be seen on perfectly sound cane, has disappeared on badly gummed cane. All symptoms of gumming seem to be more pronounced when they occur in plant cane than when they occur in ratoons. An explanation of this fact will be offered later on."

"In the sugar mill the juice of gummed cane may be recognized by the greater amount of lime required for its clarification, and there seems to be reason to suppose that the crystalization of the jellies is slower and less perfect when they are derived from healthy cane. The sieves used to separate the fiber from the juice are apt to clog up when gummed cane is being crushed. They are easily cleaned with soda."

"The foregoing symptoms are those connected with cane so attacked as to produce a marketable crop. In some cases, however, the gumming prevents the growth of the sets. The plants may reach a height of a foot or two feet, but they then die back and shoot again from the base, or from buds half-way down the stalk. In such a case the loss is total or nearly so. The gum presents the same features in this case as in milder ones."

"A microscopic examination of a thin slice across a gummed cane shows at once that the disease is not general, but local. The gum, except in certain cases, is confined to the fibers; in fact, to the sap-vessels, these latter being plugged up with gum. A cross-section of a healthy fiber shows the sap-vessels as empty spaces, the sap having flowed out in the process of cutting the section; a cross-

section of a gummed cane on the other hand shows the sap-vessels to be filled with yellow granular matter, in other words, gum. This confinement of the gum to the sap-vessels is one of the most striking microscopic features of gummed cane. In advanced cases, and in the more tender tissues at the top of the cane the gum is not so local in its distribution; it may, under such circumstances, be found outside the fiber."

"Lenses of high power show the gum to be swarming with microbes of the form known as bacilli. When the gum is fresh and yellow in appearance, the microbes are all of one kind whose features are well shown in the illustrations. This microbe appears to be one not hitherto described, and I propose to call it *Bacillus vascularum,* in consequence of its occurrence in the vessels of the sugar cane. Each microbe has about it a small amount of gummy matter, which is a product of its growth. The gum described above as issuing from the sap-vessels of the cane has, therefore, two component parts, namely microbes and viscous gummy matter. This gummy matter appears to be a new substance, and to it I have applied the name vasculin."

"Vasculin, the substance formed by the growth of the *Bacillus vascularum* as it occurs in sugar cane, is a yellowish, non crystallizable, viscid substance, having an almost imperceptible acid reaction. The taste is that of a slightly soured solution of gum arabic. A short time after oozing out from the ends of cut cane, by solution it converts ten times its weight of water into a fluid of the consistency of mucilage as used for adhesion purposes. Though soluble in water it is insoluble in alcohol. The addition of absolute alcohol to the raw substance converts it into a hard mass, but this is only owing to the abstraction of water; on placing the hardened mass in water it soon resumes its former consistancy and appearance. Vasculin is not coagulated by alcohol".

The description of the disease in Pernambuco, Brazil, in 1894 is as follows:

Gum—"The formation of a bright yellow, gummy substance, exuding apparently from the ends of the fibres on cutting the cane across. Sometimes this yellow gum, which turned orange colour on drying, appeared only after half an hour or more, at other times it appeared immediately on cutting the cane, and in such quantities as to drip from the cut ends, and in very bad times is said to have frequently checked the strainers of the raw-juice tank."

Premature death—"Indicated by the early drying up of the leaf

tips; by the successive joints becoming shorter and less in diameter as the cane grows, giving it the appearance of the joints having been telescoped one into another; by some internal parts turning red, denoting fermentation, which may have set in before or after the cane had succumbed, and by the death of the eyes."

"Any or all of these symptoms may have occurred together, and some canes, which to all outward appearance were perfectly healthy and well developed, contained a quantity of the yellow gum, together with a normal percentage of sugar".

"The canes which did not die before maturity gave no ratoons, and the juice was most difficult to work, refusing to crystallize in the ordinary way, sometimes in any way. The greatest difficulty was encountered in the 'old process' factories, probably on account of the great heat accompanying open evaporation. The Usines, with their lower temperatures, could work better, but they also at times got the 'devil in the house', especially if they did not take care to use but little lime in the defecation. The lime was frequently reduced to 10 grammes per hectolitre, and in this way the juice worked best".

Tryon described the disease as follows:

"When the presence of the disease has been determined by the use of sets derived from a badly 'gummed' crop, some of them will fail after having emitted attenuated shoots, that fail to reach the surface. Others will give rise to slender and weakly plants, which apparently struggle to survive, whilst a few will develop foliage with the individual leaves narrower and more irregular in size than if they were healthy, with the control ones yellow green and more or less crinkled and contorted, with at times, the central leaves interlaced in a tangled mass. A few of these leaves again, specially the inner ones, may exhibit bright rust-red streaks in their tissue, and this may constitute a conspicuous feature. If any such plant is cut longitudinally through the point of growth, it will be generally observed that the central shoot beyond where it joints the cane proper, instead of arising in a straight, erect manner, is more or less bent and contorted, its upward tendency having been apparently hindered. Moreover, the young cane itself, immediately below the shoot, will present one or more cavities, each containing a semi-fluid tenacious pale brown substance."

"Should the 'sets' be the progeny of a crop of cane affected but slightly by the disease, nothing very abnormal may be noticed until the cane proper has commenced to form. Then, although the

bulk of the plants will appear well-grown and perfectly healthy, others, though at first fully developed, will evince the presence of the affection in varying degree. The first symptom in a plant of its occurrence will then probably be afforded by a thin, pale longitudinal stripe arising in one of the outer leaves, in which the green colouration being discharged may gradually be giving place to brown. If this plant is divided by a longitudinal cut through its growing apex, nothing abnormal may yet be recognized. A plant in which the disease has made further progress will exhibit brown stripes of dead tissue one side of the central nerve, or along the margins of the outermost leaves, whilst on two or three of the inner ones will have appeared elongated rust-red streaks. If this plant be cut as before, very marked changes will be noticed in the tissue immediately below the growing apex. These are afforded by the presence of several cavities having ill-defined walls partly filled with an odorous yellowish substance of the consistence of pus, as well as of spots where the external tissue is becoming soft and brown to mark the site where subsequent ones may arise. These cavities occur in the intervals between nodes, whilst the denser tissue of which these latter are composed may exhibit—in small number—specks, or thread-like lines of a red colour. When still further advanced we may have a strong, healthy looking plant, with a stem measuring some 2 feet 6 inches in height from the ground to where the green foliage commences. In this several of the outer leaves, and the central ones as well, have longitudinal brown stripes or bands of dead tissue extending for the greater part of their length; and, as will be seen by a longitudinal cut, the joints or internodes immediately below the apex, to a distance of from 1 to 2 inches, are quite hollowed out, and there is considerable discolouration and softening of the tissue generally and incipient decay, both in them and in the nodes also. In such a plant the central shoot, now almost dead, may readily be pulled out."

"The disease may appear at any period in the growth of the cane, and even when it is fourteen or more months old; but these late manifestations probably generally arise when the malady is of spontaneous origin. In the first instance the central leaves are quite normal in appearance, and perfectly green and turgid, but the lateral leaves are marked by broad brown longitudial bands of dead tissue the lowermost having evidently prematurely died. The eyes on that part of the stem from which the leaves have naturally fallen have shot out, and the slender shoots thus formed are already dead;

the uppermost eyes, however, are still alive, and have not as yet sprouted."

"As an illustration of a still further advance in the progress of the malady, a plant may exhibit the following symptoms: The central shoots and leaves are already quite dead, though still flaccid, and readily yield to a slight pull. There occurs also in those, on either side of it, that are still partly green, a brown band of dead tissue, proceeding along each margin; this band widens in the case of the outer leaves, whilst the outermost of all are all involved in it, being quite dead. The cane itself, instead of exhibiting that yellowish colour indicative of the fact that it is already ripe, is of a dull bright-green colour above; nearer the ground it is clouded, with the same hue, but at the extreme base evinces little unusual in this respect. All the buds except those situated lowest on the cane have sprouted, some having given rise to peculiar elongated slender shoots; beneath the leaf-sheath the buds are already dead or apparently dying. * * * * * On cutting any of these canes across, small bright droplets of a canary-yellow thick adhesive substance will arise from the pores distributed over the surface of the section, and in many instances will run together and coalesce. When the disease is advanced to the stage above described, some of the buds within an inch or so of the decaying summit of the shoot may shoot out and develop a tuft of narrow leaves; but no further growth takes place in the cane itself, though the latter may be some time before it actually dies."

"All the canes that arise from a single stool may not be affected simultaneously and to an equal extent. As an instance of this, the following occurrences were remarked in the case of an affected plant: All the canes had been checked by cold when they had experienced from six to seven months' growth, otherwise the plant was remarkably robust. Three of them had the central shoot, and several of the lateral ones already dead. A fourth had the leaves as well as the central shoot quite green, and all of these canes exuded droplets of gummy substance when their stems were cut across. A fifth cane—the stoutest of all—was entirely wanting in the gummy exudate, as was seen when after lopping off its top and allowing it to remain still connected with the ground, none of this gum was observable even after the lapse of some hours. In addition to these five canes, there were several suckers, some of which had formed cane, and were almost as high as the stalks that surrounded them. These, however, even when arising alongside

gummy canes, were themselves apparently quite free from disease, as no 'gum' emanated from their cut ends."

Smith described the disease as follows:

"The most conspicuous signs of this disease are dwarfing, striping of the leaves, dying of the tops, decay of the heart, (terminal bud), and the appearance of a yellow slime or gum in the bundles of the stem and leaves. Many of the bundles are also stained red. Microscopic examination shows that this gum contains millions of bacteria. Cobb and Bonâme agree that there is also a reduction of the sugar-content".

"The disease is primarily one of the vascular system, but in advanced stages the parenchyma is attacked, especially the soft tissues just below the terminal bud, and cavities are formed which are filled with the yellow bacterial slime. Sometimes these cavities contain as much as a teaspoonful of the slime. In the later stages of the disease, the interior of the leaf-sheaths is rusty brown and covered with the sticky bacterial slime, which is also sometimes seen oozing from other portions of the leaf. This slime oozes from the stomata. In very bad cases the leaf-sheaths above the terminal bud are completely stuck together, so that the growing shoot can not elongate naturally, but is forced to bend on itself repeatedly and push out sidewise through the sheaths. The gumming together and pressure of the outer leaves around the terminal bud result in the doubling, twisting, and bulging of the main axis and eventually the stopping of the terminal growth. In the most pronounced cases the terminal shoot enveloped in its wrappings has a club-shaped appearance. In such cases there is sometimes a development of lateral shoots and of aerial roots".

Matz describes the disease as it appeared in Porto Rico as follows:

"The principal symptom of the disease is the yellow gummy exudation from the cut ends of the affected cane, and it is so striking that few can fail to become aware of its presence. The exudate varies somewhat in color and abundance. At times it is grayish yellow and somewhat watery but more often it is lemon yellow and thickly gummy. In almost every case, and especially where the disease was present in any marked quantity of the harvested cane, the mill men recognized the disease by this symptom before their attention was called to it. This helped to ascertain the distribution of the disease."

"At first it was thought that gum-disease cane could be recog-

nized only by the yellow gummy exudation from the cut ends of the cane, but further observation showed that the disease can be located in growing canes, before they are cut, by a peculiar appearance in the leaves. The leaves, and mostly the younger and innermost not fully unrolled ones, show, in the early stages of the gum disease, pale green to almost pure white patches and longitudinal bands or streaks. These light-colored areas become often sprinkled with dark-red small spots or narrow and short streaks. Such leaf symptoms can be found in young shoots or in older ones in the not quite unfolded basal parts of their inner leaves. In the outer maturer leaves long dark brown streaks may be found. In older cane and where the disease is more advanced the inner leaves possess long, sometimes lighter and sometimes darker gray, dead, stripes usually about 1 centimeter in width. These stripes are usually found towards the middle of the leaf blade. This feature distinguishes this symptom from the ordinary drying of leaves which occurs in cane either because of white-grub injury, borers or drought. In the latter cases the edges of the leaf commence to dry first. In gum-diseased cane the dry stripes are usually in the interior of the leaf, while the edges may remain green for a long time. This phenomenon is due primarily to the partial infection of some of the fibers; naturally only the cells surrounding the infected fibers die first and result in the dead-stripe appearance in the leaf. Usually the tops of gum-diseased cane showing the dry stripes will not be as widely unfolded as in healthy cane, the dead longitudinal areas or stripes in the leaves preventing the straightening out of the leaf blades, therefore the tops in gummy cane usually stand up erect and are more or less unfolded. In the latter stages of the disease an odorless decay sets in the tissues of the growing points of the cane. At this stage the outward symptoms bear resemblance to the top-rot condition of cane caused by borers and Plasmodiophora disease. In the last cases the cause of top rot is due entirely to the interference with the normal functioning of the fibro-vascular system. However, whether it is a bacterium as in gum disease or a Phasmodiophora as in dry top rot which fills up the water-conducting vessels, or whether it is a mechanical cut made by an insect, thus breaking the connection between the roots and top of growing point where the new leaves issue from is the same. In gumming disease, in addition to a clogging of the fibers, there is a direct decay of the tender tissues of the top caused by this bacterium as is evidenced by the red coloration of the tissues between the fibers."

"Another phenomenon found with gum disease is the red coloration of some of the fibers themselves in severely affected cane. This is not a primary symptom of gum disease, but it indicates that the phloem in some fibers, or in these which show the red color, have died. Canes which show exudation of gum from a majority of their fibers do not in many cases have a single red-fiber. In many instances a severe stunting of the stalks and the presence of grayish longitudinal depressions along the internodes was quite common. In gumming top rot there may be present masses of gum between the leaf sheaths and the stalk."

"In summarizing the symptoms of gum disease as it occurs in Porto Rico we must distinguish between the primary and secondary symptoms. The primary symptoms, or those which are always associated with gum disease, are the yellow exuding from the fibers of cut canes, the light areas sprinkled with dark-red little streaks in the younger portion of leaves, brown long streaks and light to dark gray, more or less wide dead stripes in the older leaves, and top rot. Red fibers, and even stunting of cane may or may not occur in gum-diseased cane, depending on the severity of the infection While the gum-flow symptom is the easier to detect after the cane is cut, the leaf symptoms are more important, because by these it is possible to detect the disease in the field before the cane is cut, and it should be taken advantage of in controlling the disease. Wherever possible, diseased stools should be cut after the healthy stools have been harvested. This is hardly possible in severely infected fields, but it should be borne in mind that infected machetes can introduce the disease into healthy cane."

Cottrell-Dormer describes the disease as it occurs in Queensland, Australia, as follows: "The symptoms of gumming disease in young cane vary greatly, but the most characteristic sign is the presence of large, irregular, longitudinal white patches on the young leaves. These are seen shortly, after the leaves first appear from below the soil if searched for, and are readily observed when the plant attains an age of two or three weeks. Similar signs sometimes occur on the young cane, but any doubt on the true nature of these marks may at once be settled if the set is dug out, cleaned and cut transversely into three pieces; these pieces should be placed into a closed "billy can" for a few minutes; if gumming disease is present the yellow drops of gum so characteristic of the disease will be seen to have exuded from the cut ends of the pieces. Now these plants which show these white patches on the leaves are only those

which were planted from very badly diseased canes, so that for every one of these evidently diseased plants will be a great many which were planted from slightly diseased stems, and probably will not show the disease until the cane is a great deal more mature''.

The same author also describes the leaf symptoms as follows:

Symptoms.—''The leaf symptoms enable a quick and reliable diagnosis, but they do not appear at certain seasons. The ''gum streak'' bears a superficial resemblance to streaks due to other causes. Typically, it is a yellow streak from 1/8 inch to 1/4 inch in width, of varying length, running along the veins to the leaf margin. It is almost invariably dotted with dull red, and, as it matures, becomes converted into dead tissue at that portion of the leaf where the streak originated. The streak usually begins at the margin, and works down towards the leaf sheath, but sometimes originates further down the leaf, and then elongates in both directions. The dead tissue at the point of origin spreads, and is delineated from the living by a dark red or brown margin. The gum streak is best observed between a fortnight and eight weeks after good rain has fallen; for during the warm rainy season the growing conditions of the cane are often such that the streaks do not appear. Again, after prolonged drought, the older leaves having withered, the young leaves formed no longer develop streaks. At this time the cane which is badly infected will wilt, and perhaps die. The critical symptom—the oozing of gum from the vascular bundles—should then be sought. The stalk is always pulled out, to avoid knife infection, and a portion freshly cut ends is placed in an enclosed space (a billy can) to prevent premature drying. The globules of gum which are ''sweated'' out constitute the critical symptoms of gumming. A stalk will not ''sweat'' gum unless it shows reddening of some of the fibres at the nodes, in a longitudinal section of the stem. A stool dying from gumming will always ''sweat'' gum; but in other cases if gum does not ooze the stool may be recently or lightly infected, or the growing conditions may be too moist for the gum to be evident.''

The writer of this paper has made a careful study of the symptoms on field cane, in experimental plots and in the green house and has compared notes with the preceding descriptions. The results of these comparisons are as follows:

1. Poor germination which varies with the severity of the infection. Poor germination is also due to other causes.

2. "The doubling, twisting and bulging of the main axis" referred to by Smith is rare and may be due to other causes.

3. The white patches on the leaves of young plants (Fig. 2–6 & 17) described by E. F. Smith and by Cottrell-Dormer occur in less than one per cent of canes grown from infected seed. I doubt if it ever occurs except on canes from severely infected seed. The writer sectioned some of these white areas and found the cells filled with bacteria. However, it is well known that chlorosis may be due to other causes.

4. The bent and contorted tips described by Cobb are rare.

5 The most reliable external symptom is the leaf streaks (Figs. 7–10) referred to by Matz and Cottrell-Dormer. However, this symptom is sometimes present on the POJ canes, and occasionally on Uba and some other canes, although it is impossible to find any trace of gumming in the cut surfaces. The writer has found the organism in these streaks on the leaves of infected canes.

6. The dying of the tops occurs in severe cases and may be due to any one of many other causes. The gumming of the top leaves occurs in cases of very severe infection.

7. Young canes die in the infected stools in numbers varying with susceptibility and severity of infection. The "eye spot" (*Helminthosporium sacchari*, Butler) and the dry top rot (*Plasmodiophora vascularum*, Matz) will produce the same symptoms.

8. The red fibro-vascular bundles which have been referred to in gum canes are so common in sugar cane that they must be considered of little or no importance as a diagnostic character. The writer has examined and made cultures from the discolored tissues in a large number of canes without finding any evidence of gum or bacteria.

9. The presence of the gum (Fig. 1) is the only sure sign of the disease. The statement by Cottrell-Dormer that "a stalk will not sweat gum unless it shows reddening of some of the fibres" is not true in Porto Rico.

The writer offers this description of the symptoms of the gum disease as he has found them in Porto Rico. The description is drawn from a study of the varieties referred to in the tables of this paper.

(1) The most reliable external symptom of sugar cane gummosis is the presence of leaf streaks (Figs. 7–10) which usually appear soon after the nodes are visible above ground. These streaks appear soon after the leaves are fully unrolled and usually start

at the margin and work inward along the fibro-vascular bundles but sometimes start in the interior of the leaf and work in both directions. They are rarely more than 1/4 inch in diameter and are usually yellow or light green. A little later they develop reddish dots (Fig. 8) usually arranged irregularly in two lines. These dots may occasionally appear in the green tissue without being preceded by the yellow streak. This reddish color increases, becomes brownish and the tissues finally die (Figs. 9–10). The dead brownish strips of tissue referred to by Matz are common but much less reliable than the yellowish streaks and reddish dots. This symptom may be present on POJ and occasionally on other canes which do not show the slightest trace of gumming.

(2) In older canes, broad stripes of dead tissues (Fig. 10) extending from the margins into the leaves may be sufficient cause for suspicion on susceptible varieties and in localities where the disease in known to occur. This stage usually follows the yellow streak, but sometimes appears in healthy canes.

(3) Diseased canes give a low germination and the young plants are occasionally twisted and doubled. A very few plants show broad white stripes and white areas. Brownish red dots frequently develop in these chlorotic plants. Plants of various ages and sizes die as a result of the disease and these plants are very soon attacked by the so-called rind disease fungus (*Melanconium sacchari* (Cke.) Mass.)

(4) The dying of the tops is characteristic in the case of canes that are severely infected, but this symptom may be due to any one of many other causes. The development of shoots from lateral buds is common in severely infected canes but may be due to any one of many other causes. The formation of new shoots from top of diseased cane may be due to other causes as well as to gummosis.

(5) The formation of a honey yellow gum (Fig. 1) on the cut surfaces of infected canes is the only sure indication of the disease. In slightly infected canes it may develop as small drops on the cut ends of the fibro-vascular bundles but in severely infected canes the entire cut surface may be covered with a thick layer of gum. The variation in color of the gum, the fibro-vascular bundles and other tissues may be due to other causes.

(6) The leaf symptoms are more pronounced during wet than during dry weather. During periods of drought there may be no leaf symptoms on cane known to be infected, but these symptoms will be developed very rapidly following a heavy rain fall.

CAUSES

It is very generally recognized that "the disease is caused by *Bacterium vascularum* (Cobb), Greig Smith, which Dr. Erwin F. Smith describes as a 'honey yellow'. one flagellate organism, which forms the yellow slime always present in the vessels of diseased plants. It is a short rod, occurring singly, in pairs, fours, or eights (end to end) and it often exists in practically pure culture in the fibro-vascular bundles of the diseased sugar cane."

THE ORGANISM

The causal organism can be found in great abundance in the gum which oozes from the cut surface of infected cane. In cases of severe infection a teaspoonful of gum be may scraped from the cut surface while in the case of mild infections the gum oozes out from one or more fibro-vascular bundles in small drops.

The gum has been described by Dr. Erwin F. Smith and others as "honey-yellow", but we found it varying from perfectly clear to milky white, to many shades of yellow, and occasionally orange, red and brown. Our inoculation experiments were not extensive but they indicate that the organism in all cases was pathogenic. Although Cobb describes the gum as yellow, he also states that "this gum is sometimes nearly transparent, sometimes rather opaque, and varies also in color from nearly colorless into various tints of yellow according to the stage reached by the disease". The writer is inclined to believe that the variations in color may be due to many causes such as acidity of medium, age, variety of host, etc. The red color appears to have been due in some cases to the influence of a very small fungus sometimes found growing in the tracheary tubes When the organism was separated from this fungus in culture, the bacterial growth resumed the white or yellowish color. The fungus appears to belong to the genus *Fusarium* or near related genus. It is white but produces a red color in the media. It grows in the tracheary tubes but is difficult to demonstrate because it clings very closely to the wall.

Both Cobb and E. F. Smith state that the gum is the product of the organism and not of the desintegrating cells of the host plant. The writer agrees with this statement.

Several writers refer to the drying of the gum on the cut surfaces. This is also true but it is very soluble in water and easily removed by rain.

The culture made from the second cutting of our field experiments (1928) showed a much larger number of clear and milky colonies and a much smaller number of the yellow, red and brown colonies.

A red bacterium which was very common in the cultures was very distinct from the *B. vascularum.* It was not pathogenetic but appeared to live saprophytically in the fibro-vascular bundles.

The cultures involved the use of sixteen different media containing various mixtures of cane sugar, cane juice, glucose, peptone, $K_2P_2O_4$, $MgSO_4$, beef extract, oat meal and potato. The organism grew in both large and small colonies which were always semi-liquid in texture and raised above the surface of the medium.

The growth in the media varied to some extent with the severity of infections in the canes from which the cultures were made. The colors remained very constant except in the case of the red color to which we have referred and the yellow which sometimes became white when transferred to the beef extract medium. The organism retains its vitality in culture for more than twelve months but the growth becomes less vigorous with time. The writer also found the living organism in dead seed pieces two months after planting. These infected seed pieces had been planted in pots for experimental purposes but were so severely infected that they died without producing shoots. The gum in the seed pieces at time of planting was yellow but the gum in the dead pieces was very clear. The organism from these dead canes was capable of producing the disease.

The prevalence of other colors in the gum and in the tissues is so common that it is worthy of special attention. Smith (**21**) says: "In the majority of these red bundles bacteria were no longer to be seen In place of them was a red formless mass. Red and yellow bundles were inter-mingled in the stems; however, often the same bundle would be both red and yellow, *i e.,* variegated, the yellow parts being filled with bacteria. The same phenomenon has been observed in maize, inoculated with *Bacterium stewarti,* except that in the latter case the variegated bundles were yellow and brown. The red pigment was most pronounced in the nodes and immediately under them. This was observed in many canes. Without exception there was more pigment in the upper part of the internodes than in the central or basal portion, but by far the greater part was in the nodes, where often nearly all of the bundles

were as red as blood. Probably this localized pigmentation is due to greater aeration through leaf-traces centering in and immediately under the nodes. In the sugar cane, as in the sweet corn, the pigment does not appear in the first stages of the disease, and the writer is inclined to think that the reddening of the bundles is a later stage than the yellowing. Valeton makes the same observation respecting Sereh. Plates poured from bundles showing red ooze yielded only the yellow colonies of *Bacterium vascularum*, indicating that this red ooze, was due not to red bacteria but to a red reaction on the part of host-plant. Perhaps the formation of this pigment would not be as noticeable in all varieties of sugar cane as in common green cane. It is not a sign peculiar to this disease of an entirely different nature."

Smith also found yellow and red bundles in canes which he had inoculated and says: "I am inclined to think that the reddening of the bundles is a later stage of the disease than the yellowing".

Smith also found the white bacterial ooze in canes which were received from Australia and says: "No attempt was made to get cultures from the most badly decayed of these canes, because in places the bacterial ooze was nearly white, indicating an extensive mixture of organisms in the stem".

Smith also found the black discolorations in canes which he had inoculated and says: "There are at least 100 bundles affected in the inoculated internode. About half of these are black and a few red, but there are a large number which show the yellow bacterial ooze".

R. Greig Smith made a study of red vascular bundless in 1904 and found a pycnidia bearing fungus and a bacillus which he describe as *B. pseudarabinus*. He says:

"In glucose-gelatin the mould produced a brilliant crimson-scarlet color, and it undoubtedly was the agent which was primarily responsible for the color of the strings. But from the presence of gum in the vessels I was of the opinion that the phenomenon of red gum was brought about by the simultaneous growth of two organisms, a mould and a bacterium This view was confirmed during the research. It may, however, be mentioned here that every portion of red vascular bundle that was taken did not contain the mould, but did contain slime-forming bacteria; and from this we must conclude that the mould does not accompany the gum along the whole length of the string, but colors the gum which is carried along the vessels, perhaps by sap-pressure, perhaps by bacterial

growth, or that the rapid growth of the bacteria starves out the mould after the color has been produced. At any rate two things are certain: (1) The mould can, under certain conditions, produce the color and cannot produce the slime, and (2) the bacteria do produce the slime".

He did not reproduce the disease by inoculation but obtained a red color by inoculating a plate with both the fungus and the *B. pseudarabinus*. He did not obtain the color when he inoculated the plate with the fungus and the *B. vascularum*.

The writer does not consider the discoloration of the tissues of importance. These discolorations may result from any condition which interferes with the growth of the cane, insect-injury, disease or as a result of over-maturity, and are frequently found in growing canes which are apparently healthy and normal. The writer has made a large number of cultures from discolored fibro-vascular bundles and other tissues and while fungi and bacteria are frequently found, many of them do not give a growth of any kind. Furthermore, the fibro-vascular bundles and tissues of infected canes may not show any discoloration or only slight tinting with yellow.

INOCULATIONS

Numerous inoculations from pure culture were made. In general the susceptible canes contracted the disease while the resistant varieties remained healthy. However, in a number of cases the susceptible varieties failed to develop the disease.

Carefully selected infected seed of all the susceptible varieties used in our seed plots were planted in the green house and observed for a period of twelve months. The most severely infected seed pieces died. Some few stools showed a gumming in the young canes but no gumming in the mature canes. Many of the slightly infected seed pieces produced cane without symptoms and were apparently healthy in every way. The medium infected seed pieces produced the disease and gave the following symptoms:

1. An occasional plant showed distortion in coming through the ground.

2. Several plants showed white blotches or white stripes on the leaves.

3. After the formation of the nodes, several varieties showed the leaf streaks (Figs. 8–10) described on page 158.

4. The canes with the leaf streaks showed the gum.

THE PATHOLOGIC HISTOLOGY OF THE HOST

The response of the host to the parasite varies greatly with the variety of the cane and with the age of the tissues at time of infection. Susceptible varieties and young canes or the young tops of older canes show a greater amount of internal injury than resistant varieties and old canes. Smith (**21**) gives a number of excellent illustrations of the morbid anatomy of the host plant but his discussion is very limited.

The specific name of the organism (*vascularum*) indicates that it lives in the vascular tissues and this is true in the case of resistant varieties and in old canes, but it frequently invades the parenchyma tissues of susceptible varieties and of young canes.

In resistant varieties and in old canes, especially the basal part, the organism is usually confined to the tracheary tubes and there is very little or no disintegration of the tissues (Figs 11, 17). In such cases the injury is physiologic since the plugging of the tubes interferes with the movements of the water in the plants. In more severe cases the cell walls are dissolved, the first to disappear being the cross walls or partitions in the tracheary tubes. In more severe cases the rings and other thickenings inside the tubes are destroyed and fragments are frequently seen in the mass of gum and bacteria which fills the tubes (Figs. 12, 13, 18, 19, 20, 24, 25, 26). In extreme cases the side walls of the tubes are dissolved (Figs. 19, 27) and the bacteria invade the parenchyma tissues (Figs. 14, 16, 21, 22, 23, 29, 30) in which the walls are more or less completely destroyed. The writer has never found the extreme destruction of tissues, except in the very susceptible varieties, such as Otaheite, Cristalina and Rayada, and in young canes and in the tops of old canes. In these very severe cases the young canes and the tops of old canes are killed. The bacteria may be found in any cells of the fibro-vascular bundles except in the sclerenchyma cells (Fig. 17) but there is very seldom any tendency to the disintegration of the tissues, except in the very susceptible varieties and the very young tissues. In the severe cases when the tops gum and die, the tissues in this region are almost entirely disintegrated and form a soft, gumming, slimy mass. The bacteria can also be found in the intercellular spaces of the parenchyma and in parenchyma cells where the cell walls are uninjured. This is especially true in the chlorotic areas of the leaves of infected canes and in the young tissues of susceptible varieties.

The organism appears to travel through the tracheary tubes with

the growth of the canes. It is always most active in the younger parts of the tubes. In fact, it appears to die out in the older parts, leaving the gum which hardens and contracts. The contractions result in a pulling away from the walls of the tube or formation of cracks in the gum (Figs. 24, 26).

The organism follows the fibro-vascular bundles into the leaves and causes the yellowish or whitish stripes along the veins, which have been referred to in the discussion of the symptoms. In severe cases, it causes a disintegration of the cell walls and spreads into the surrounding tissues as in the cane (Fig. 27). When the leaves are fully spread and exposed to the wind, the dead tissues become dry (Figs. 9 & 10). When the leaves become severely infected before they unroll, a slimy mass of bacteria and a disintegrating tissues is the result (Fig. 22). In young canes the entire shoot dies, while in old canes the top dies and gives the characteristic dead top symptom.

A comparative study of sections of a large number of varieties leads the writer to believe that the more fibrous canes are more resistant than the canes with a low fibrous content. The old varieties of canes were of low fibre content and were well adapted to old machinery for grinding. The improved machinery enables us to grind the high fiber canes and thus to eliminate the old varieties which are so susceptible to gummosis, mosaic and other diseases.

FIELD PLOT TESTS

Through the kindness of the authorities of Central Columbia near Maunabo, a plot of one and one-half acres of good uniform cane land was set aside for experimental tests. This was planted to varieties in rows of forty-five stools, except in the case of a few varieties of which there was a shortage of seed cuttings. In these cases we used one-half or one-third rows. Two seed pieces were planted in each stool. Every third row was planted with infected Crystalina cuttings so that each variety came in contact with infected cane on one side. The plantings were made October 16th, 1925, and observations to determine symptoms were made from time to time during the growing season. The first cutting was made February 16th, 1927, and the second February 7th, 1928.

The symptoms during the growing season showed little evidence of the disease and did not correspond with the percentages of gumming at time of cutting. Therefore, the writer is of the opinion that external symptoms during the growing season are a very poor index of the amount of infection. In every case that has come to the

attention of the writer, the percentage of gummosis in susceptible varieties was higher than indicated by external symptoms.

Considerable difficulty was experienced in determining a method for estimating percentages of infection: (1) because a considerable number of stools died and it was impossible to determine the cause with any degree of certainty; and (2) because many young canes died from this and possibly other causes and cannot be included in the count; and (3) because the infections were very slight in some cases and very severe in others. *It was finally decided to base the percentages on the actual number of living canes showing gum as compared with the number which did not show gum at time of cutting.*

All of these facts are shown in Table 1. The mill records are of little importance because it is well known that these figures will vary with the ages of the canes at time of cutting.

NOTE: After this paper was in type some question was raised as to the desirability of giving the number of stools infected at time of first cutting. Those who are interested in this data will find the figures in Table VI (page 179). However, it should be remembered that the infections in some stools may occur in only one cane while in other stools the infections may occur in all the canes. Therefore, the writer is of the opinion that the percentages given in Table I are of greater value than the data in Table VI because it gives a better idea of relative resistance and susceptibility.

TABLE I

	1925	1927		1928		1927 Mill record		
	Number of stools planted	Number of stools living	Percentage of disease	Number of stools living	Percentage of disease	Brix	Sucr	Pur
PR-491	45	0						
H 109	15	15	100	11	63 7	15 7	13 78	87 7
PR 460	45	45	100	33	12 4	15 2	13 17	86 6
PR 260	45	45	100	36	22 2	13 7	9 14	66 7
B 6292	75	75	100	67	10 5	18 2	15 75	86 6
Otaheiti	45	6	100	2	100	13 8	10 61	76 0
B 6308	45	40	86	37	0	18 6	15 02	80 7
Cristalina	1260	1130	85	942	9 3			
PR 487	15	13	80	12	91 6	17 5	13 06	74 6
D 504	15	12	66	8	12 5	16 8	13 96	83 0
B 6032	45	31	66	31	0	16	13 90	85 2
I K 28	15	14	63	14	50	20	17 03	85 1
D 1135	45	39	64	39	0	16 7	13 18	78 9
Rayada	90	70	55	64	3 1	16 6	14 20	85 0
St Kitts	15	14	45	14	0	19 8	19 00	95 9
D 109	90	77	42	77	0	17 5	14 58	83 3
PR 292	15	9	53	8	0	16 6	14 20	85 5
N 62	45	35	3	26	7 7	15 8	12 75	80 6
Ba 11569	45	42	28 5	12	7 1	20 9	19 64	93 9
Badila	45	41	27	41	0	15 6	12 37	79 2
B 3405	45	40	25	40	12 5	17 9	12 42	69 4
B 3696	45	40	17 5	38	0	17 7	13 61	76 8
B 3412	45	40	17 5	40	0	18 6	13 86	74 5
PR 492	90	66	17	66	0	18 0	14 79	82 1
PR 528	45	26	15	2	4	19 7	17 28	87 7
PR 417	45	38	15 1	54	0	20 6	17 52	85 2
GC 493	15	8	13	7	0	19 4	14 72	75 9
B 1809	45	41	12 2	38	0	19 6	17 23	87 9
Yel Cal	45	35	14 3	35	0	19 4	13 52	69 6
B 1753	15	12	8	8	0	18 1	16 27	87 8
PR 333	45	27	7 4	25	0	19 5	15 94	81 7
D 117	45	30	6 6	30	0	17 8	15 82	88 8
D 433	45	33	6 1	33	0	17 7	12 00	79 2
TC 214	45	33	6	33	0	18 2	15 90	87 3
PR 219	20	17	5 9	17	6	18 9	16 45	87 0
PR 329	45	51	5 9	31	0	14 7	9 67	75 7
TC 306	75	54	9 5	51	0	17 4	15 50	89 5
SC 12(4)	90	77	2	76	0	21 7	19 77	91 4
P R 202	15	12	8 3	12	0	19 4	16 91	81 7
PR 729	45	32	1	30	0	16 7	13 24	79 2
PR 358	45	38	1	37	0	16 9	15 44	91 3
PR 230	15	11	1	9	0	18 2	14 79	81 2
PR 67	45	45	1	40	0	18 4	14 79	81 2
B 208	45	42	1	54	0	19 4	16 91	87 1
BH 10(12)	160	133	1	130	0	1 9	20 37	93 0
PR 318	15	12	0	12	0			
D-448	45	41	0	35	0			
POJ 979	15	7	0	7	0	17 7	15 0	86 40
POJ 826	15	9	0	8	0	18 8	17 20	91 4
POJ 234	15	13	0	13	0	17 8	14 87	87 4
POJ 228	15	14	0	13	0	16 0	13 93	87 0
M 36	22	22	0	22	0	18 6	16 04	86 2
Uba	45		0	45	45	19 9	15 22	76 4

A comparison of the amount of infection at first and second cutting is shown a little more clearly in Table II which gives percentages only.

TABLE II

First Cutting.	Second Cutting.
I. 100 per cent infection—	
PR-260	
PR-460	PR-491
PR-491	PR-487
H-109	
B-6292	
Otaheiti or Blanca	Otaheiti or Blanca
II. 80 to 90 per cent infection—	
PR-487	
B-6308	
Cristalina	
III. 60 to 70 per cent infection—	
PR-504	
Ba-6032	
D-1135	H-109
EK-28	
IV. 50 to 60 per cent infection—	
	EK-(exact 50%)
Rayada	Cristalina
V. 40 to 50 per cent infection—	
D-109	PR-460
St. Kitts	
VI. 30 to 40 per cent infection—	
PR-292	Cristalina
X-62	(Some rows. Many other rows not infected.)
VII. 20 to 30 per cent infection—	
B-3405	PR-260
Ba-11569	Cristalina (Some rows.)
Badila	
VIII. 10 to 20 per cent infection—	
PR-492	Cristalina (Some rows.)
PR-417	D-504
PR-328	B-3405
B-3696	B-6292
B-3412	
B-1809	
Yellow Caledonia	
GC-493	

TABLE II—Continued

First Cutting	Second Cutting	
IX 1 to 10 per cent infection—		
PR-329	X-62	
PR-333	Cristalina (9 rows)	
PR-219	PR-328	
FC-306	PR-219	
FC-214	Ba-11569	
D-433	Rayada	
D-117		
B-1753		
SC-12(4)		
PR-202		
X Less than 1 per cent infection—		
PR-729		
PR 358		
PR 202		
PR 230		
PR 67		
B 208		
BH 10(12)		
XI No infection—		
PR-318	POJ-979	POJ-826
D 448	POJ-234	GC-493
POJ-979	PR 492	
POJ-826	Cr [illegible] (10)*	FC-306(2)*
POJ-234	PR-729	PR 318
POJ 228	D-433	SC-12(4)(2)*
M 36	B 6032	PR-729
Uba	FC 214	B-6308
	St Kitts	B-1753
	B-3696	B-208
	B 67	B-1809
	B 3412	PR-492
	PR-333	PR 417
	BH-10(12)(4)*	PR-329
	D-109	PR-358
	D-117	D-1135
	SC 12(4)*	D-448
	Yellow Cal	Badila
	PR-230	Uba
	PR-292	PR 202
	POJ-234	M-36

* The figure in parenthesis indicated number of rows without infection

It will be readily seen that the amount of infection was much less at time of second cutting that at time of first cutting That only one variety (P R 487) showed a higher percentage of infection at

second cutting and only one variety (P. R. 219) showed the same percentage at second cutting. All the other varieties showed a lower percentage at second cutting except P. R. 491 in which all plant were killed. The tendency for the disease to be more severe on plant than on ratoon cane and to vary in amount from year to year has been noted by others in Porto Rico with whom the writer has talked. This has also been noted by workers in other parts of the world. We have already called attention to the fact that the reports indicate a reduction of the disease in Porto Rico during the year following 1921, until the severe outbreak in 1925. In one of Cobbs early Australia publications he says: "All symptoms of gumming seem to be more pronounced when they occur in plant cane than when they occur in ratoons." In a more recent publication North of Australia says that the disease apparently disappears in some places and reappears in others.

All of PR-491 died the first year, presumably as a result of this disease.

Only six stools of Otaheiti were living at the end of the first year and only two at the end of the second year and there was a 100 per cent infection in both instances. The second Brazil report (1892) says: "The unfortunate 'Otaheiti' cane, or 'Cayanna' cane, as it is called in Brazil, was here as elsewhere the principal victim, and nine-tenths of the cane grown was of this kind". Matz also records it as strongly susceptible.

H-109, PR-460, PR-260 and B-6292 all showed a 100 per cent infection the first year but with no loss of stools. However, the number of living stools and also the percentage of infection were reduced the second year. The writer is unable to give any explanation as to the cause of the death of these stools, unless the weaker plants died as a result of the disease the first year. The fact that the cane is more severe on plant than on ratoon cane, emphasizes the importance of using disease free cane for planting.

It will be noted that of the 53 varieties used (not including Cristalina), that there was a reduction of living stools during the second year. The tonnage was also less the second year. It is the opinion of the writer that a considerable part of this loss was due to the disease and that a very small part was due to other causes. This also emphasizes the importance of making every possible effort to control the disease.

It will also be noted that all varieties except Otaheiti and PR-

219, showed a lower infection in the second than the first year Was this due to a killing of the weaker individuals during the first year or to other agencies? We do not have data to answer this question which must be left open for future study

The notes of the writer record the first year infections of one row of BH-10 (12), Ba-11569, B-6308, PR 202 and one row of Cristalina as slight The infections on the individuals canes were slight but the percentage of infected canes was as indicated in table III

TABLE III

Variety	First cutting	Second cutting
Cristalina *.	100	61
B-6308	86	0
Ba-11569 .	28.5	7.1
PR-202.	8.3	0
BH-10 (12) .	5.9	0

* One row only, 45 stools

Therefore it will be readily seen that relative severity of infection and percentage are not the same Two varieties or two rows of the same variety may show the same percentage of infection but the infection may be more severe in one case than in the other These varieties showed a high percentage of infected canes but the infections were very slight

At the time of first cutting only one variety showed chlorosis GC-493 showed a 13 per cent infection and one stool with chlorosis

The writer used twenty-three varieties that had been used by Matz and the comparative results may be of interest. However, it should be noted that the methods were different Matz inoculated the canes with pure cultures of the organism while the writer planted apparently healthy seed cuttings in rows parallel and five feet distant from rows planted with infected seed cuttings of Cristalina The writer has no data by which it is possible to judge the relative merits of the two systems but Matz says in regard to his own system:

"This method is not quite satisfactory since it does not represent a truly natural state of affairs, but it shows the possible susceptibility of each variety" The comparative results on the twenty-three varieties is shown in Table IV The grouping in the first column is according to Matz; the Roman numerals in the second and third columns correspond to the Roman numerals used in Table II.

TABLE IV

Matz	Cook First year	Cook Second year
I. Strongly susceptible		
Otaheti	I	I
Rayada	IV	IX
Cristalina	II	*
PR-491	I	I
II. Slightly susceptible		
PR-260	I	VII
B-3405	VII	VIII
PR-328	VIII	IX
III. Susceptible when young.		
B-208	X	XI
IV. Resistant or immune.		
Uba	XI	XI
D-448	XI	XI
Yellow Caledonia	VIII	XI
B-3412	VIII	XI
D-117	IX	XI
B-6292	I	VIII
D-109	V	XI
PR-202	IX	XI
PR-230	X	XI
BH-10(12)	X	XI
PR-383	IX	XI
PR-292	VI	XI
PR-318	XI	XI
PR-417	VIII	XI
PR-219	IX	IX

* Cristalina gave variable percentage at second cutting.

The results are not radically different. The most striking differences were with two varieties:

TABLE V

Variety	Matz	Cook First Year	Cook Second Years
		Percent	Percent
PR-260	Slightly susceptible	100	22.2
B-6292	Resistant or immune	100	10 3

Although Matz did not do row-to-row planting with diseased and healthy seed cuttings he did conduct one test comparable to the writer's work. This is best described in his own words:

"Stools of cane which contained several diseased stalks were dug up and all the stalks and shoots cut back. The stubble with their roots were transplanted amongst young healthy canes in an isolated field. It was noted that some young shoots which came up from

those diseased stools showed at the very beginning the symptoms of gum disease, and what is more significant the disease was later found in the adjacent healthy stools as well. It is therefore evident that the infected ratoons left in the field constitutes a positive source of infection and that the disease can be carried over from these to the young canes of healthy stools. The possibilities are, therefore, that the disease can be transferred to growing cane by insects, by the cutting instruments and by driving rains, but by eliminating the diseased ratoons the primary source of infection is destroyed, since the soil does not form a favorable abode for the bacterium. Artificial inoculations in the roots of susceptible canes gave negative results. This can not be explained on the ground that the acidity of the soil does not favor growth in the bacterium''.

The writer made plantings of diseased seed cuttings of all the varieties recorded in Table I in the green house at Río Piedras and found that in most cases, slightly infected seed cuttings gave apparently healthy plants, that the majority of severely infected seed cuttings died and that the medium infected seed cuttings gave the greatest number of diseased plants. Percentage records were not made in this test because the number of cuttings of each variety was too small for satisfactory percentages.

The writer also inoculated growing plants and seed cuttings with pure cultures of the organism but found the results very irregular. In many cases susceptible varieties did not always produce diseased plants.

No experimental work on transmission was conducted by the writer. However, it is very evident that the disease can be transmitted by the seed cuttings. The character of the organism and nature of the disease are such that we would expect it to be carried on the cutting knives and by insects but we have no data on either point in Porto Rico. However, the work of both Matz and the writer show very clearly that the disease can be transmitted from stool to stool and row to row. The writer planted severely infected seed pieces in large pots. Some of them died without producing shoots. Two months later, a clear gum was found on freshly cut surfaces of these seed pieces. Cultures were made and the organism found to be very much attenuated but capable of transmitting the disease. No effort was made to determine whether the organism could be transmitted in the soil but a test by Matz should be mentioned in this connection. He says:

''Gum-diseased cane pieces, the buds of which were removed split

and these were tied to healthy seed planted in new soil. Twenty seed of each of the varieties Caña Colorada, Yellow Caledonia, Rayada, Otaheiti and PR-260 were used in the trial, each variety being planted in a separate row. In addition five seeds of each of the above varieties were planted in the same rows but alone without infected cane. Practically all the healthy seed in this whole planting germinated and no sign of disease was noticeable in the young plants in spite of the fact that at first their buds and later their roots had been in contact with gum diseased cane pieces which were gradually decaying in the soil. They all made a good normal growth, and when the whole plot was harvested at the age of eight months, there were no traces of gumming in the stalks of any of the varieties used. The ratoons of these canes sprouted normally and no disease symptoms were noticeable in them when they were cut 10 months later. Apparently the soil is not the proper means through which infection might be carried to the roots of healthy seed. In another experiment diseased seeds were planted with the view to allow those to sprout, as only 25 per cent germinated healthy Otaheiti seeds were planted in the holes of the ungerminated seed. There was no gum disease produced in the replants of the susceptible Otaheite in this manner. However, when *Bacterium vascularum*, isolated from diseased cane, was introduced with a needle into the young leaf spindle of Otaheite and Rayada canes growing in the field the disease was reproduced with all its symptoms. That indicates that the air route is the path of transmission for this disease."

DISCUSSION

Our studies on this disease show that it is very serious and very destructive on susceptible varieties. Although it may vary somewhat in severity from year to year, it causes a reduced yield in tonnage and interferes with the crystallization of the sugar in the mills. Although the amount of the disease may be greatly reduced and it may even disappear at times, the planting of infected seed is likely to result in losses in the succeeding crop. In all cases that have come under our observation, the percentage of infection was higher in plant cane than in ratoons but the tonnage was less in the ratoon than in the plant canes.

There is a very great variation in the susceptibility of varieties as shown in the tables of this paper. It will be noted that some of our old varieties, such as Otaheiti, Cristalina and Rayada are very susceptible. These varieties appear to be low in fiber in comparison

with the very resistant canes. Possibly their low fiber content is the cause of their being such great favorites with the early growers who were compelled to use the crude and inefficient mills of the past. Improved machinery makes it possible to grind the more fibrous canes which have been coming in use in recent years.

An examination of the tables shows that some of our favorite canes, such as BH–10 (12) and SC–12 (4) are very resistant to this disease. Therefore, it appears that we can control the disease by growing resistant or immune varieties which are as good or better than the susceptible varieties.

We recommend (1) that our growers abandon varieties that show a susceptibility of more than 5 per cent; (2) that they do not use seed from crops in which the disease has been found; and (3) that diseased crops be destroyed and the fields replanted with healthy seed of resistant or immune varieties.

The presence of this disease on the island will prevent the introduction or development of new, improved varieties which are susceptible to the disease. The introduction of an insect capable of carrying the disease might result in serious complications. Therefore, our growers should use every possible measure for the eradication of the disease.

SUMMARY

1. Gummosis of sugar cane is a bacterial disease, caused by *Bacterium vascularum* (Cobb) Grieg Smith.

2. The organism lives in the tracheary tissues of the fibro-vascular bundles. Sometimes it dissolves the cell walls and spreads into the surrounding tissues of susceptible canes and into young tissues of somewhat resistant canes.

3. The organism produces a gum which oozes out of the cut ends of the infected canes.

4. The disease kills many young canes and causes a reduced yield, varying with the susceptibility of the variety and the severity of the attack.

5. The gum also interferes with the crystallization of the sugar in the mills.

6. The percentage of infection is higher on plant than on ratoon cane but in all cases that have come under our observation, the yield on the ratoons was reduced.

7. The leaf symptoms are more pronounced during wet than during dry weather.

8. Many of our best varieties in Porto Rico are immune or highly resistant. Therefore, the disease is not a serious problem if these varieties are used.

9. Immune or resistant varieties should be used in Porto Rico. Infected cane should never be used for commercial planting.

The writer wishes to express his thanks to Commissioner C. E. Chardon for valuable advice and assistance, to the proprietors and manager of Central Columbia for land and cooperation in the field experiments and to Mr. Francisco Ortiz who had charge of the cultivation of the field for the very valuable asistance rendered by him.

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EXPLANATION OF PLATES

PLATE I

Fig. 1. Cane showing the exudation of the gum.
Figs. 2–6. Chlorosis due to gummosis on young cane of 15 inches or less.

PLATE II

Figs. 7–10. Leaf symptoms on older cane.

PLATE III

Fig. 11. Section at base of cane showing the organism confined to the tracheary tubes.
Fig. 12. Section of fibro-vascular bundle showing the beginning of the disintegration of the cell-walls.

Fig. 13. Longitudinal section showing disintegration of the cell-walls.

Fig. 14. Section of parenchyma tissue showing cells filled with the organism and slight disintegration of cell-walls.

Fig. 15. Section through a dying top showing the disintegration of the host tissues into a slimy mass containing fragments of cell-walls, gum and bacteria.

Fig. 16. Longitudinal section through parenchyma tissue showing disintegration of cell-walls.

PLATE IV

Fig. 17. Cross section of part of fibro-vascular bundle showing distribution of the bacteria in the cells.

Figs. 18–19. Longitudinal section of fibro-vascular bundle showing disintegration of cell-walls and tracheary rings.

Fig. 20. Cross section of fibro-vascular bundle in the streak of a leaf in which the bundle is almost entirely disintegrated.

Fig. 21. Parenchyma cell showing bacteria.

PLATE V

Figs. 22–23. Parenchyma tissue undergoing disintegration.

Fig. 24. Longitudinal section in which the old gum has hardened and pulled away from the wall or one side of the tracheary tube. No bacteria visible in this section.

Fig. 25. Cross section showing same as in figure 31.

Fig. 26. Cross section showing same as in figure 32 except that the hardened gum has cracked.

TABLE VI

	Number of living stools	Number of stools showing infection
H-109	15	15
PR-460	45	45
PR-260	45	45
B-6292	75	75
Otaheiti	6	6
B-6308	40	39
PR-487	13	12
D-504	12	10
B-6032	31	3
EK-28	14	14
D-1135	39	29
Rayada	70	49
St. Kitts	14	10
D-109	77	38
PR-292	9	5
X-62	35	30
Ba-11569	42	12
Badila	41	11
B-3405	40	10
B-3696	40	7
B-3412	40	7
PR-492	66	12
PR-328	26	7
PR-417	38	5
GC-493	8	2
B-1809	41	5
Yel. Cal.	35	5
B-1753	12	4
PR-333	27	2
D-117	30	2
D-433	33	6
FC-214	33	3
PR-219	17	1
PR-329	34	2
FC-306	54	7
SC-12(4)	77	2
PR-202	12	12

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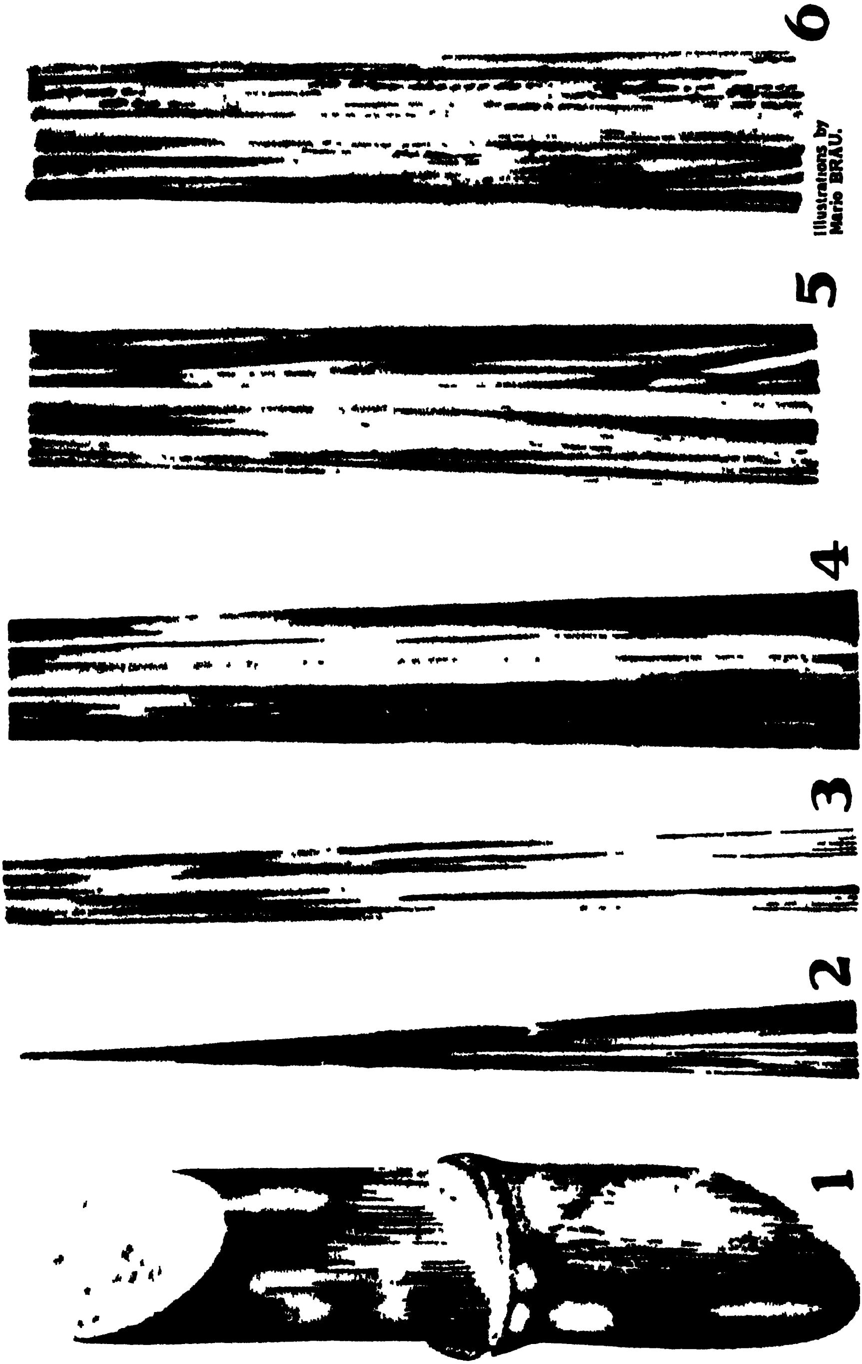
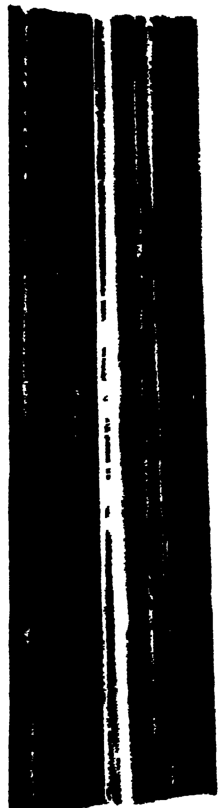
PLATE I





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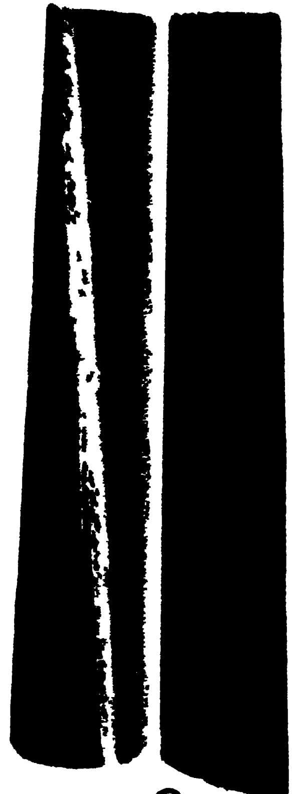

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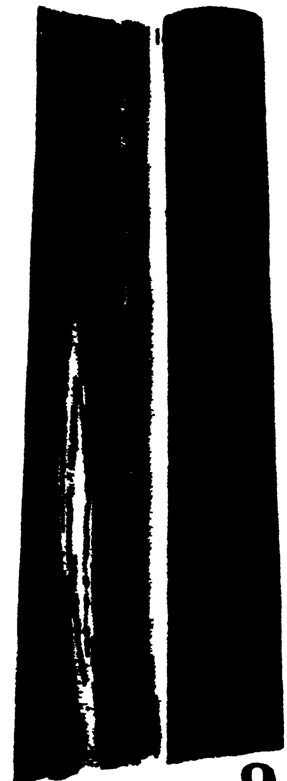

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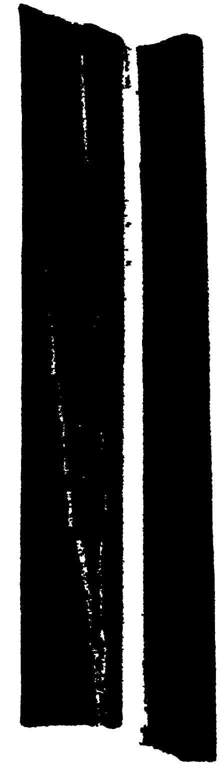

Illustrations by
Mario BRAU.

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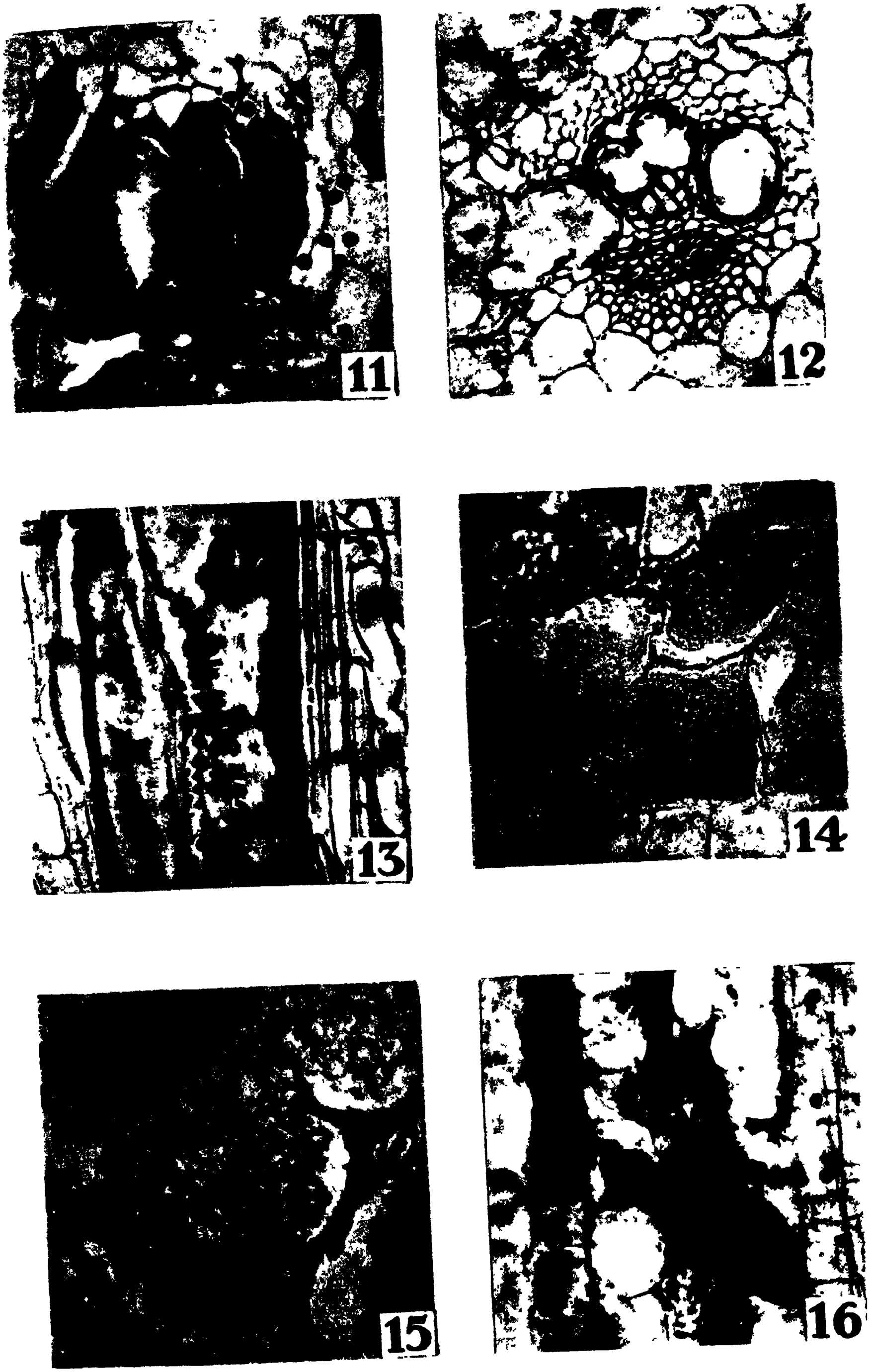
PLATE III



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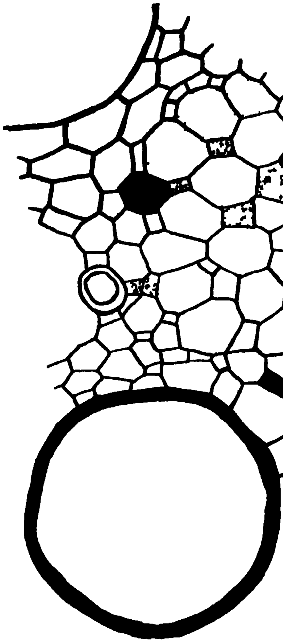
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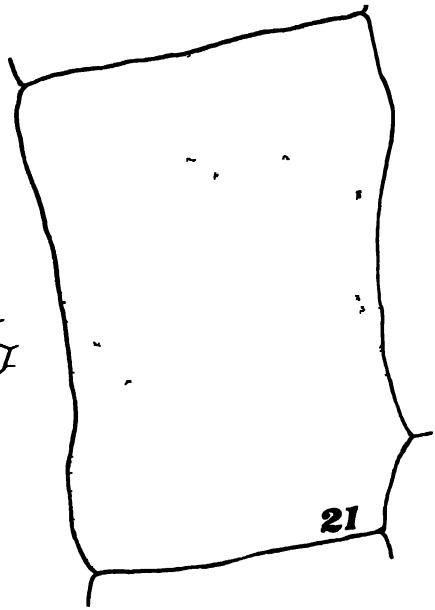
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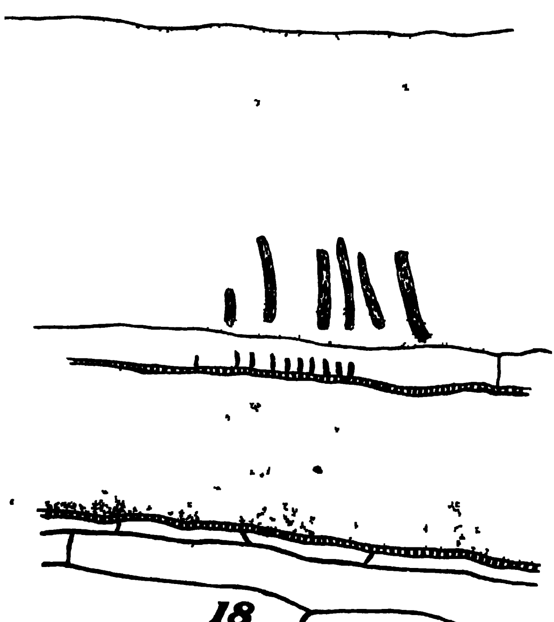
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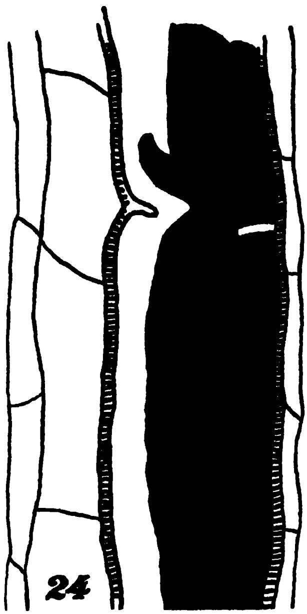
PLATE V



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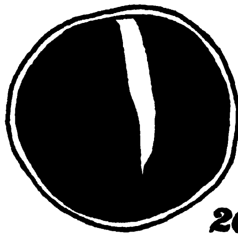

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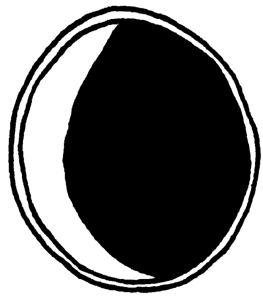

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THE BLACK-SHANK OF TOBACCO IN PORTO RICO

by

J. A. B. NOLLA

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THE BLACK-SHANK OF TOBACCO IN PORTO RICO[1]

J. A. B. NOLLA, Assistant Plant Pathologist, Insular Experiment Station

Following a definite policy assumed by the Insular Experiment Station relating to a detailed study of tobacco diseases, a survey of the most important tobacco regions was made in the fall of 1926. Among other maladies a serious disease known among the laborers in tobacco fields as "pata prieta" and similar to or the same as the American black shank, was found on a type of commercial cigar wrapper tobacco. No studies had been made in Porto Rico prior to 1926 on this important malady. Although the growing of the cigar wrapper tobacco was quite an industry in the island at the time our investigations were begun it has now disappeared. Other factors aside from the disease, have been responsible for this failure of a once flourishing industry. It is not our purpose to discuss them at this time. But suffice it to say that the question of the variety and type has been a dominating factor. Let better types of tobacco which may be adapted to our conditions of soil and climate such as exist today be developed and safeguarded from degeneration, and the growing of cigar wrapper tobacco will again assume the proportions it once held. Further, the black-shank has also been found in certain localities on cigar filler types and its prevalence in fields of this tobacco might increase in the future. It seems proper to give the results of our studies on this disease in Porto Rico at this time.

PLANTS AFFECTED

The pathogene (*Phytophthora nicotianae* Breda de Haan) which causes black shank of *Nicotiana tabacum* L. has been reported by Breda de Haan (2) as attacking Amaranthus sp. and Androng weed in Java, while Palm (8) found the castor oil plant (*Ricinus communis* Linn), the tomato (*Lycopersicum esculentum* Mill.) and *Commelina nudiflora*, to be susceptible and the potato (*Solanum tuberosa* L.) not susceptible. He also found *Trema amboinensis* susceptible, under certain conditions. Tisdale and Kelly (12) found

[1] This investigation was made in cooperation with the Porto Rican Leaf Tobacco Company, the only growers of cigar wrapper tobacco in Porto Rico.

that tomato, potato, the castor oil plant and eggplant (*Solanum melongena* L.) would develop disease symptoms when inoculated.

In our experiments we have tested the castor-oil plant, potatoes, peppers and eggplant. The pathogene causes the wilting of the leaves of eggplant inoculated at the axils and also death of terminal buds in plants which are beginning to form the first flower bud. Eventually, it kills the whole plant. Potato stems have been inoculated and death of the tissues has been produced by the fungus but lesions are localized and limited in extent. Damping-off, black-shank and leaf spot have been produced on *Ricinus communis* seedlings, growing on infested soil. Some plants transplanted into infested soil did not show the disease, but later on, at blossoming time, upon being dug out, they showed a general blackening of the epidermis and cortex of roots and underground part of stem from the tissues of which the fungus was recovered. The fungus also produces "damping-off" or "bending off" of eggplant, tomato and pepper seedlings under favorable conditions.

Varietal Susceptibility.—Tisdale and Kelly (12) tested 18 cultivated varieties of *Nicotiana tabacum* and the percentage infection ranged from 90 for Big Cuba (Type E) to 100 for 12 of the remaining types and varieties. The remaining five types and varieties ranged between 95 per cent for a Porto Rican type to 99.5 per cent for Commercial Broad Leaf. *Nicotiana rustica* showed 30 per cent infection in a population of only 54. They consider *N. rustica* showing this percentage of infection as a "highly resistant variety to the disease." As will be seen later in our studies we have not considered a variety to be highly resistant which shows as low as 26.08 per cent diseased individuals. That would be about one fourth of the crop and, certainly, growers would be risking too much when growing varieties which might contract the disease to such an extent. Tisdale (11) reports that five varieties of bright or flue cured tobacco tested were found to be "highly susceptible."

In Porto Rico natural field infections occur most virulently and aggressively on the "Borinquen" (Connecticut Round Tip) tobacco, a cigar wrapper type imported from the United States and grown extensively by the Porto Rican Leaf Tobacco Co. of Porto Rico up to 1927. Field observations and laboratory studies have proved this variety to be the most susceptible of all wrapper varieties of tobacco in Porto Rico. Cases where 80 per cent of the crop was affected have not been rare. In an experimental plot at the Experiment Station grounds about 100 per cent infection was recorded. A type of cigar wrapper tobacco selected and improved in the island from

its own stock has proved very resistant, in fact almost immune. A field of tobacco of this variety grown side by side with a field of the Connecticut Round Tip variety demonstrated, beyond all doubt, that the Porto Rican type was very resistant. Counts were made of the Connecticut Round Tip field which showed about 40 per cent infection as contrasted with no diseased individuals in the adjoining field of the Porto Rican variety. The fact that the two varieties were grown in separate fields detracts from the value of this count and naturally raises doubt as to whether the second field where the apparently resistant variety was grown was infested with the causal organism. However, the two plantations were separated only by a narrow path and irrigation ditches ran up and down both fields, with all the chance for the inoculum to be constantly carried from the diseased field to the healthy one. Frequent talks with Dr. G. H. Chapman, until recently Field Manager of the Porto Rican Leaf Tobacco Co., and other members of their field force, showed that the disease had been severe on the Connecticut Round Tip in previous years where the Porto Rican type was growing in 1926–27.

As an introduction to our studies on varietal susceptibility an attempt is here made to describe briefly all the varieties and strains with which we have dealt. Mention has already been made of the "Borinquen" (Bor) and Porto Rican wrapper varieties. A mammoth variety designated as *Experiment Station* (*Expt. Sta.*), was obtained from a gardener at the Experiment Station, who discovered it by mere chance in one of the cutting propagation beds. This plant, because of its high susceptibility to black-shank, has been very useful in our investigations.

The "Ceniza" (Cen) variety is a well-selected native cigar filler tobacco. This and the variety "Virginia Blanco" (probably the best Porto Rico cigar filler) have been selected and propagated by Mr. F. H. Bunker, Tobacco Expert of the Insular Department of Agriculture, during the last few years. They are the most sought for varieties in the island today.

The variety *Consolation* (Con.) is a yellow-leaved cigar wrapper variety which appears to be a mutant from one of the Porto Rican cigar filler varieties. It was grown extensively for wrappers in the Cayey-Aibonito district until 1927 when it was discarded.

"Vuelta Abajo" (V), is a variety imported from Cuba, and grown for wrapper in 1926–27. Its culture has been abandoned.

The strain J–18 was developed by Dr. G. H. Chapman from "Virginia Blanco".

"Magnolia" is a Cuban tobacco grown to a small extent for filler in 1926–27 and for both filler and wrapper purposes in 1927–28.

"Gigante" is a semi-mammoth tobacco grown in the Cayey district. It is of the filler type.

"País"—Under this name are included a number of Porto Rican filler varieties or strains, most of which are of doubtful economical value.

The following data were gathered in a plantation on relatively high land. The two varieties "Ceniza" and "Virginia Blanco" were grown in the summer of 1927 for seed by the Porto Rican Leaf Tobacco Co. in Caguas. Black shank appeared in late summer. Counts were made early in the season of all the healthy plants. Diseased plants were pulled out at intervals. At the end of the season counts were made of the healthy plants.

The results are given in the following table.

TABLE No. I

Incidence of Disease in Two Varieties of Commercial Filler Tobacco

Variety	Population	Diseased individuals	
		Total number	Percent
Virginia Blanco	4,663	749	16.06
Ceniza	464	121	26.08

The differences in population in the two varieties does not allow of a reasonable comparison. Yet it is clear that these varieties are not so highly resistant as had been generally supposed in the island. The "Virginia Blanco" with 16.06 per cent infection should be considered as fairly resistant.

The *Consolation* variety is quite resistant to black shank. Plants grown in pots with infested soil have not developed symptoms except in a few cases. That this would be its behavior in infested fields has not been ascertained. It was not further tested since it is no longer of commercial importance. The type "Vuelta Abajo" has shown high tolerance to black shank. Inoculations in pots nearly always produce symptoms of the disease although the plants are able to survive while similarly inoculated varieties like "Borinquen", for instance, readily succumb to infection. "Magnolia" tobacco is quite susceptible. Both field observations and inoculations show this to be true. "Gigante", in comparison with "Ceniza" shows to be as susceptible as the latter. All the types "País" have not been tested. There is only one type obtained from the Porto Rican

Leaf Tobacco Co which has been planted in our grounds and inoculated with the black-shank pathogene All inoculated plants became infected but a number of them were able to reach complete development Plants received from various places in the tobacco sections including two specimens from the coastal plain (Bayamón), upon examination showed the causal pathogene present in the lesions at the base of the stem Plants received from Jayuya in May showed the disease

In the following table are given the results of counts of diseased plants in a number of strains, varieties and first generations of crosses

TABLE No 11

Incidence of disease in different varieties and arrangement of rows in the field The varieties J-18 (rows 60-72), Ceniza (rows 73 82) and *Experiment Station* (rows 83 85) on one end of the field grown with no shade, all other varieties and crosses under cloth.[1]

Variety strain cross	Row No	Population	Diseased plants: Total number	Diseased plants: Percent
Con x V (1st gen)	1 2	151	2	1 32
V x Con (1st gen)	3 4	128	3	2 35
V x Cen (1st gen)	5 6	161	6	3 73
Cen x V (1st gen)	7 8	172	6	3 43
V x Exp Sta (1st gen)	9 10	167	85	50 89
Exp Sta x V (1st gen)	11 12	182	128	70 33
Bor x V (1st gen)	13 14	178	44	24 72
V x Bor 1st gen)	15 16	129	55	42 64
Con x Exp Sta (1st gen)	17 18	178	34	19 10
Exp Sta x Con (1st gen)	19 20	182	28	15 38
Cen x Exp Sta (1st gen)	21 22	173	96	55 49
Exp Sta x Cen (1st gen)	23 24	180	142	78 89
Bor x Exp Sta	25 27	208	208	100 00
Exp Sta x Bor	28 29	173	173	100 00
Exp Station	30 32	262	262	100 00
P R R Gr 3	33 35	246	3	1 22
P R R Gr 8	36 38	257	9	3 50
P R Ind 6 P 1	39 41	247	4	1 62
P R Ind 7 P 1	42 44	255	12	4 70
P R Ind 1	45 47	257	8	3 11
P R Ind 2	48 50	279	8	2 87
P R Ind 3	51 53	284	19	6 69
P R Ind 4	54 56	279	17	6 09
P R Ind 5	57 59	275	5	1 82
J 18	60 72	1 190	18	1 51
Cen (Ceniza)	73 82	908	44	4 85
Exp	83 85	269	250	92 94

Types P R R Gr 3 and 8 as well as P R Ind 1 7 are all individual selections from the previously mentioned Porto Rican variety, made by various members of the field force of the Porto Rican Leaf Tobacco Co P R R Gr 3 and 8 come from one plantation (Río Grande plantation) and P R Ind 1-7 from another,

[1] Data of population was taken as soon as the transplants showed a vigorous growth, thus eliminating those plants killed by insects during the first few weeks The data on diseased individuals was gathered at intervals and a final count of plants standing healthy at blossoming time was made to check with the figures on diseased plants already collected

the Industria Plantation The latter were selected by Mr Pedro Ferrer and the former by Dr G H Chapman.

In general, the results given above show all the P R selections to be highly resistant to black-shank The most resistant strain seems to be P R R Gr 3 with only 1 22 per cent infected plants and the most susceptible, the P R Ind 3 with 6 69 per cent infection The populations are not equal in the two cases

It might be well to consider the results of these selections in two sets, the P R R Gr on the one hand and the P R Ind on the other. P R R Gr 3 and 8, together make a population of 503 with 12 dis eased individuals and a percentage of infection of 2 39, P R Ind 1–7 together make a total of 1,876 plants with 73 diseased ones and a 3 89 per cent infection Since both sets of selections were made from the same variety namely, P R wrapper, it is well to collect the results into one group Thus, the nine varieties would represent a population of 2,379 individuals with 85 diseased ones among them The percentage infection for the variety would then be 3 57 A variety with such a low percentage of susceptibility should be con sidered very resistant, especially if compared with the variety *Expt Station* grown in the same field and in adjacent rows and showing an almost complete susceptibility – 92 94 and 100 per cent infection

First generations of direct and reciprocal crosses between Borin quen and *Expt Station* (the two types which are very susceptible) showed a similar high susceptibility—since all the plants died No seed could be saved for a second generation The first generation population of direct and reciprocal crosses between "Ceniza" and *Expt Station* showed high susceptibility, yet one of the parents ("Ceniza") showed only 1 54 per cent infection in the same field *Expt Station* and Ceniza showed 78 89 per cent of diseased plants while Ceniza and *Expt Station* had 55 49 per cent infected individuals The population was about the same for the two cases The first generation crosses of resistant types showed a high degree of resistance under the conditions in which the susceptible type *Expt Station* failed and where the crosses between susceptible types showed high susceptibility The results of counts of diseased plants in direct and reciprocal crosses indicate a lower percentage of infection in first generation plants of crosses between a resistant and a susceptible parent *V* (Vuelta Abajo) and *Con* (*Consolation*) are resistant types, while *Bor* (Borinquen) and *Expt Station* are very susceptible. In the cross *Con* × *Expt Station* the percentage of infection was lower than in the cross *V* × *Expt Station* which was again lower than the infection in *Bor* × *Expt Station* These results would

tend to show the higher resistance of each type predominating in the first generation They are in line with the relative resistance of each individual type As will be shown later these types are arranged according to their resistance to the disease as follows: *"Consolation"*, "Vuelta Abajo", etc and lower down in the list is "Borinquen"

In the same table the results are given of three varieties grown without shade but in the same location as those already discussed

The J 18 strain showed an infection of 1 51 per cent as compared with 4 85 per cent for "Ceniza" The *Expt Station* variety here again displays its high susceptibility with about 92 94 per cent diseased individuals The fact that the *Expt Station* type showed a lower percentage of infection—only 7 06 less—when grown without shade may be due to the fact that the land dries out more quickly when unshaded Further, it should be stated here that these fields were subject to very high humidity at intervals They were under water thrice and in each case the water remained in the ditches for a few days These last three varieties grew on a slightly higher land than the other varieties which appear in the table

It is evident that the "Ceniza" variety is very resistant to the disease as is also true of the strain J–18 *Expt Station* is by far, the most susceptible of any of the varieties tested First generation populations of crosses between this and "Borinquen" and "Ceniza" are very susceptible to the attacks of the black shank

Summarizing our observations and results we are tentatively grouping the varieties of tobacco of any economic importance in Porto Rico according to their degree of resistance to black shank as follows

Most resistant 1 Puerto Rico cigar wrapper type
2 "Pais" cigar filler type
3 *Consolation* cigar wrapper type
4 J–18, cigar filler type
5 "Vuelta Abajo", cigar wrapper type
6 "Virginia Blanco", cigar filler type
7 "Ceniza", cigar filler type
8 "Gigante" (semi mammoth) cigar filler type
9 "Magnolia", cigar wrapper and filler type
10 "Borinquen", cigar wrapper type
Most susceptible 11 *Expt Station* (mammoth) not a commercial type

It has already been pointed out that even the highly resistant types when inoculated will, in most cases, become infected, the dif-

ference between them and the very susceptible ones then being in their ability to tolerate infection. Infection in the former has not shown as lethal effects as on the susceptible types.

THE DISEASE

NAMES

What is probably the same disease as the American black-shank is called "Lanas" or "bibit" in the Dutch East Indies. In Porto Rico it is generally called "pata prieta" by the laborers and some growers. This term is an attempt at the translation of the English "black-shank". It probably originated when some one who was familiar with or had read about the disease in the United States tried to apply some name to what appeared to him as the same disease described from that country. Sometimes one hears foremen in tobacco fields call it "Faitapia". The Spanish pronunciation for this word faintly sounds to the ear like Phytophthora; and probably that is the way the word Phytophthora sounds to the non English speaking persons who hear the name from some American field manager. Another trouble caused by the same fungus in transplants is called "hinchado" (swollen) by the farmers, because the seedlings seem to become swollen at the base of the stem.

HISTORY AND RANGE

The first published report of the disease from Porto Rico appears to have been made in 1924 by Dr. Mel. T. Cook (3). He states that a shank disease caused some losses in the field. He does not give the cause of the disease. However, personal talks with members of the staff of the P. R. Leaf Tobacco Co., who have been working in the shade tobacco fields for a number of years, have convinced the writer that the malady existed in the island many years prior to 1924, although it seems probable that it was introduced from abroad. The disease had not been found on the sun crop tobacco varieties to any large extent. A few specimens of these types were received by the author in the fall of 1926 and they showed the characteristic symptoms of black-shank. That they were attacked by the pathogene responsible for black-shank was confirmed by laboratory studies. Later in the summer of 1927 it was noted that the disease was spreading on the cigar filler types and sporadic cases were found in Caguas during the months of January and February.

In the United States what is in all probability the same malady is supposed to have been introduced from some other country, Tisdale and Kelley (12). The disease probably did not exist before 1915

in the Florida-Georgia district. It has been spreading there since that year. Subsequently, it has been reported from Alabama in 1924 (Tisdale and Kelley) and in the same year from Virginia by Wingard and Godkin (13). Breda de Haan (2) reports its existence in Java since the year 1895. Horne in 1909 (5) reported a wilt disease of tobacco from Cuba, which, judging from his description, inoculations and statement that a fungus similar to that causing damping-off in the seed beds was found in the affected parts, ("*Un hongo aparentemente el mismo que causa la pudrición en los semilleros, ha sido hallado sobre las partículas descompuestas*.") is probably the same we have been studying.

IMPORTANCE

Were the shade tobacco industry to be revived in Porto Rico, measures would surely have to be taken to grow varieties which would resist or tolerate the "pata prieta" or black shank disease. The Connecticut Round Tip variety, aside from other undesirable qualities, has the great disadvantage of being very susceptible to black-shank. There were heavy losses produced on fields of this variety in recent years. The return must then be made to other types. Yet under certain conditions even the now resistant varieties might, if selection is not constantly made, gradually become more susceptible. Losses are heavier during seasons of heavy rainfall and floods.

In the seedbeds the losses have increased from year to year. The disease occurs in the seedbeds both in the form of damping-off and a leaf blight. Our observations and experiments show that the form of damping-off and the seedling blight produced by the black shank pathogene are more injurious than the damping-off produced by the fungus *Pythium debaryanum* Hesse. In the fall of 1927 more than 50 per cent of the seedbeds were destroyed by the damping-off caused by the black shank and the latter fungus. As a result of shortage of plants there was a short crop of tobacco that year. We are convinced that the black-shank fungus will more and more be a dominating factor in the production of tobacco seedlings. Tisdale and Kelley (12) report no direct injury to seedlings in the Florida-Georgia district. It causes injury however in seedbeds in Java (2).

Black-shank has been supposed to be harmless to filler types of tobacco by various growers. The data offered in the preceding paragraphs on varietal susceptibility show that this is not the case. That filler types are also liable to contract the disease normally in the field is further proven by cases observed during December, January and February in the Caguas district. Upon the suggestion of Mr

Nelson Márquez, Deputy Inspector of Agriculture in that district, the writer visited a mixed planting of "Virginia Blanco", "Ceniza" and "Borinquen" varieties where we found plants of all these varieties with typical black-shank or "pata-prieta" symptoms. The "Borinquen" plants probably came as a mixture in the filler types. Most of the plants of this variety ("Borinquen") were diseased. Other similar cases of black-shank in filler types were observed in low, level lands near streams.

Plants received in May from Mr. F. González, Agricultural Agent at Jayuya, showed the typical symptoms of "pata-prieta" or black-shank. Laboratory studies showed the presence of the pathogene which causes this disease. The time may not be far distant when these sporadic infections may become more generalized in the commonly grown commercial filler types, as has been the case in the shade tobacco.

SYMPTOMATOLOGY

Morphologic symptoms.—The malady "pata-prieta" or black-shank derives its name from the most characteristic external manifestation of the disease, a blackening of the lower or basal portion of the plants. Roots are also affected. There are many cases in which plants wilt and die as a result of the destruction of the roots before any blackening of the stem has appeared above the surface of the soil. The lesions in the roots occur as small brownish spots which soon develop into long necrotic brown, hazel or black areas extending all the way down or up the root and involving other neighboring roots. Thence infection moves beyond the root system and into the stem. Usually only a number of the secondary roots are affected. Still there are other cases in which the black necrotic areas have extended high up the stem without much destruction or blackening of the roots. In these cases the infection probably occurred at the base of the stem. The disease starts in the stem at the surface of the soil, if conditions are favorable, and it rapidly advances up the stem and down the roots. The stems of large plants may show lesions a foot or more above the base, but usually not more than six inches in length. All plants thus affected rapidly wilt, hence the name "sueño" (sleep), applied to it by the laborers. Then yellowing, shriveling and finally browning of the lower leaves ensues, especially if a dry period follows infection. Gradually the majority of the leaves take on this appearance.

In plants which become infected when only about a foot or less in height, the disease, if weather relations are favorable, advances from roots to stem and up to the growing bud, the entire stem taking

on a black appearance, shriveling and falling to the ground. The foliage, whose blades are still green for about half of their length, gives the apperance of leaves arranged radially and alternately in a circle on the soil

On the leaves the pathogene produces spots which are at first circular in outline then changing to irregular blotches or patches. These are at first pale greenish or olivaceous, later pale or creamy in the central portion immediately surrounded by a light brownish discoloration, limited by the pale green zone near the healthy tissues. The pale color develops only when dry weather follows infection. If the atmosphere is humid the fungus rapidly extends from the point of inoculation and produces a rotting of the blade This rotting follows its way through the vascular bundles into the petiole and thence into the stem The symptoms on the leaves of large plants are similar in every respect to those produced on seedlings in the seedbeds The spots occur mostly on the "sand" or lower leaves but may also appear on the lower middles The fungus penetrates hairs and causes them to shrivel

A fungus which was found to be the pathogene which causes the disease under discussion was isolated from transplants which failed to develop a root system The seedlings were transplanted during the heavy downpours of late October and early November in Cayey. This trouble extended over an area of 32 acres in three different farms The leaves remained apparently healthy, but no progress was made by the transplants Upon examination of such plants it was found that new roots failed to appear, the stem below the surface of the soil had become slightly swollen and of a dirty white or very pale green color There was a slight discoloration of the tissues below the cortex

The disease produces small, lens-shaped to elongate, brownish to black lesions on the stems of large seedlings while still in the seedbed; these do not seem to affect the plant much in the beds except for the stimulation of adventitious roots This root development is probably induced by the fungus infection The lesions do not cause the death of such seedlings in the bed but when they are transferred to the field the fungus under favorable conditions then produces a general infection resulting in the death of the plants If the weather is dry, however, the plants may recover.

The damping-off phase of the disease will be discussed in greater detail in another publication.

The symptoms on *Ricinus communis* seedlings are as follows: (*a*) on the leaves the spots which are at first olivaceous in color

later become pale yellow or creamy They enlarge and gradually cover the whole blade of the young leaves This disease follows its course down the petiole to the stem which it destroys to a distance of about ¾" below the axil In few cases it destroys the whole seedling The leaves shrivel up and die New leaves may develop when the disease is limited to the cotyledon leaves

(*b*) On stems when inoculation has taken place about ½"–1" from the surface of the soil on seedlings about 2½" high, the first symptom is a change in color from an ashy green to a brownish black The affected tissues shrink The lesions enlarge both laterally and longitudinally and may reach the growing tip

(*c*) On the roots Invasion is not infrequent through the roots The primary root is usually the first one to show any symptoms. Lesions appear on the roots as brownish spots which gradually extend over the whole root and into the stem

Signs Conidia and sporangia are produced in abundance on the surface of stem lesions near the soil The pathogene as a saprophyte in the soil and in dead roots also fructifies heavily and it is probably in this phase that the majority of the spores which go to produce secondary cycles are formed They are also found at the end of mycelial threads on the surface of spots on leaves, in particular, during rainy weather Chlamydospores are very common and may be found in the tissues of the leaves, stem and roots or in the soil Oospores are produced by the fungus but not in abundance They are formed in the old dead roots, stems and leaves and in greater numbers in the soil in debris Zoospores are found in large numbers in low places where the water collects Such water if examined in the morning will be found to contain sporangia germinating and liberating their zoospores

Histologic symptoms The symptoms are characteristically of the necrotic type Soon after penetration of the pathogene the first apparent symptom is hydrosis, followed by discoloration of the primary walls of epidermal and subepidermal cells The hyphae are both intra and intercellular, generally intracellular They penetrate into the vascular bundles and may be found going across the bundles through phloem and xylem The cortex is usually affected, the hyphae causing the dissolution of the parenchyma cells These gradually shrink under the drying and sinking epidermis

The hyphae seem to encounter no barrier in the tissues that would check their progress, such as is reported by Braun (1) for *Pythium complectens* Braun which causes geranium stemrot, etc The parenchyma cells of the pith are sometimes also affected In the early

stages they become stained brown, olivaceous or greenish, their primary walls are dissolved and they begin to lose their turgidity Later stages show a shrunken black, dry pith

ETIOLOGY

Name, history and classification of the pathogene—The pathogene which causes "pata-prieta" in Porto Rico is probably the same as that causing black-shank in the United States and "Lanas" or "bibit" in the Dutch East Indies, namely, *Phytophtora nicotianae* Breda de Haan The fungus was described in 1895 by J van Breda de Haan (2) Tisdale and Kelley (12) have found that there were slight differences in morphological and physiological characters between the pathogene from America (Florida-Georgia) and *P. nicotianae* from Java

In our studies we have endeavored to compare our cultures with the pathogene from Forida and that from Sumatra and have carried in comparison a Phytophthora isolated from tomato seedlings as a check Comparison with other species of Phytophthora did not seem justified as similar investigations have been already made by Tisdale and Kelley (12) The cultures used in this investigation were as follows P1 isolated from diseased seedlings, Cayey, P R, P3, isolated from diseased seedlings, Cayey Model Farm, P4, P10 and P14, isolated from diseased plants from the field, Caguas, P R, P16, *Pythium de Baryanum*,) from tobacco seedlings, Caguas, P R, P17, tobacco transplant disease, Cayey, P R, P18, *Phytophthora* sp isolated from rotting tomato seedlings, Río Piedras, P R, P20, (*Pythium de Baryanum*) from cucumber seedlings, Río Piedras, P216 (*Phytophthora nicotianae*, the Florida black shank organism), obtained from C M Tucker of the Experiment Station at Mayagüez, P R, who secured it from Tisdale of Florida, and a culture from Sumatra also obtained through the courtesy of Mr Tucker

The morphology of our cultures was critically studied and compared with that of *Phytophthora nicotianae* from Florida Unfortunately, the Sumatra culture of this pathogene did not sporulate well and not as many reproductive bodies were observed, as were desirable. However, since Tisdale and Kelley (12) have already compared their pathogene with what they call strains of the fungus from Holland and Java, we feel justified in drawing conclusions from comparisons with the Florida black-shank pathogene

Measurements of length and width of sporangia were made from 14-day-old oatmeal agar cultures Table III contains the lengths of various populations

TABLE No III

Lengths in microns of sporangia of cultures of *Phytophthora nicotianae* (P1, P3, P17, and P216) and of an undetermined species of Phytophthora from tomato (P 18)

Culture	Population	Maximum	Minimum	Mode	Mean
P1	277	58 6[illegible]	27 [illegible]0	44 8[illegible]	46 653±0 230
P3	283	86 2[illegible]	27 60	48 30	49 822±0 319
P17	206	[illegible]	20 70	48 30	47 197±0 385
P216	203	75 90	20 [illegible]0	37 9[illegible]	42 799±0 388
P18	145	69 00	[illegible]5 13	11 40	17 359±0 599

It appears from the above table that no safe conclusions can be drawn from differences in lengths of sporangia of our cultures (P1, P3 and P17, the Florida black-shank pathogene (P216) and the Phytophthora from tomato (P18) It appears that cultures which agree on minimum length show different upper limits The mean length of our cultures varies from 46 653 ± 0 230 microns to 49 822 ± 0 319 microns, while that for the Florida pathogene is 42 799 ± 0 388 microns Tisdale and Kelley (12) gave the measurements for length of the sporangia on oat meal agar as 34 44 microns which is considerably lower than ours for the same pathogene

The check, P18, shows a mean length almost equal to that of our P17

From mean lengths alone one would be inclined to regard the Porto Rican fungus (P1, P3, P17) as constituting a strain different from P216, since the differences are quite significant

A similar state of things is encountered with respect to widths of sporangia Dimensions of widths were recorded in the same manner as, and simultaneously with the lengths Table IV shows the widths of sporangia

TABLE No IV

Widths in microns of sporangia of cultures of *Phytophthora nicotianae* P1, P3, P17, and P216) and of an undetermined species of Phytophthora from tomato (P 18)

Culture	Population	Maximum	Minimum	Mode	Mean
P1	277	51 75	24 15	34 50	38 754±0 246
P3	283	55 20	20 70	37 95	39 291±0 271
P17	206	51 75	17 25	41 40	39 177±0 342
P216	203	51 75	17 25	30 05	33 834±0 331
P18	145	46 58	17 25	30 05	35 811±0 351

In the above table P216 shows minimum and maximum widths of sporangia equal to those of P17 but with a much lower mode, from which it appears that fewer spores had a small diameter in P17 than in P216. The population was about the same in the two cases

Other results of maximum and minimum width comparisons with the remaining cultures do not mean much in this case. It is significant, however, that three of the *P. nicotianae* cultures had an equal upper limit of spore width and among them was the culture from Florida.

In relation to mean widths it is evident that the differences among P1, P3 and P17 may be attributed to chance. Here again as in the case of the mean lengths the cultures from Porto Rico fall together under one class, the differences between these and P216 being significant enough. The mean of check culture P18 is also significantly different from either P216 or any of our cultures.

Considering the means of lengths and widths together we find the dimensions as follows: P1, 46.653 × 38.754 microns, P3, 49.822 × 39.291 microns, P17, 49.197 × 39.177 microns, and P216, 42.799 × 33.834 microns. The Florida black shank fungus is given by Tisdale and Kelley (12) as measuring 34.44 × 26.18 microns which is a lower figure than that obtained by us. They give the average dimensions for the Java strain as 38.2 × 28.98 microns and for the Holland strain 36.67 × 25.30 microns.

These writers assumed their pathogene to be a distinct strain of *Phytophthora nicotianae* Breda de Haan. They based their assumption on "slight differences in the morphological and physiological characters."

Rosenbaum (9) in studies of the genus Phytophthora, made use of the ratio of length to width of sporangia in the separation of species. Our results on such ratios in the cultures (see table V) under study show they are not of much value in the delineation of possible strains or lines. Thus, P216 which according to the mean lengths and widths of sporangia, stands in a class by itself, here would seem to be equal to P3. P18, the Phytophthora from tomato, has ratios almost similar to the preceding. P1 and P17 have equal ratios.

TABLE No. V

Shows lowest, highest and modal ratios of lengths to widths of sporangia of *Phytophthora nicotianae* and an undetermined species of Phytophthora from tomato

Culture	Population	Lowest	Highest	Mode
P1	[illegible]7	1 1	1 [illegible] 1	1 2 1
P3	283	1 1 1	2 5 1	1 3 1
P17	206	1 1	1 [illegible] 1	1 2 1
P216	208	1 1 1	2 [illegible] 1	1 8 1
P18	145	1 1	2 6 1	1 8 1

Summarizing the results of measurements of sporangia one is inclined to regard the Porto Rican cultures P1, P3 and P17 as probably the same strain P216 (the Florida pathogene) differs somewhat from ours and we shall tentatively call it a different strain. Both should be placed as strains of *Phytophthora nicotianae* Breda de Haan

Size of Chlamydospores—Rosenbaum (9) in his investigation of members of the genus Phytophthora, among them *P nicotianae*, says

"As in the case of conidia, great variation in size occurs within the species," etc However, he does not give any data on the variation in size of the chlamydospores within any particular species The problem appears then to be, how much value may be placed on differences obtained in spore measurements in populations of any two or more pedigree lines within a definite species.

The mean diameters of chlamydospores of the same cultures (lines) employed above follow The population in these varied from 189 to 233 P1 · 35 003 + 0 292, P3 35 302 ± 0 387, P17 40 087 + 0 549 P216 31 038 ± 0 318 and P18 29 344 + 0 287

The difference in mean diameter of P1 and P3 is not significant That between P216 and P1 is very significant, about 9 times its probable error That between P216 and P3 is about 8 5 times its probable error, between P216 and P17 it is about 14 times its error, while that between P17 and P3 is about 7 times the error All of the latter are significant It is of interest to note that the difference between P216 and P18 is only about 4 times its error If much reliability were placed on the size of chlamydospores in this genus one would at least regard P1 and P3 as the same strain but different from P17 and P216 which would again appear to be different from each other and should logically be considered distinct strains However, that this should not be done is shown by cultural characteristics and pathogenecity studies which are given later.

Rosenbaum (9) held that "the separation and relationship of species should be made on the aggregate of characters", although he laid particular stress on morphological characters.

Leonian (6), on the other hand, regards morphological caracteristics as of minor importance and has offered a key for the separation of the species of the genus Phytophthora based on physiological reactions In his own words: "The average of all morphological, pathological and physiological features should form the specific sphere".

The delineation of strains within a species of this genus seems

to offer similar difficulties. Size of reproductive bodies alone does not seem to furnish a valuable means of separation. We have tentatively regarded P1, P3 and P17 as one strain and P216 as another strain of *P. nicotianae*. We shall now see how these behave in other reactions and how true this assumption holds.

Cultural characteristics.—The behavior of the cultures of Phytophthora, used in this work toward certain media is given below. Measurements of diameter of colonies were taken in every case nine days after planting on the media. The culture dishes employed were of a 90 × 10 mm. size. (See table VI.)

TABLE No. VI

Growth of various cultures of *Phytophthora nicotianae* and Phytophthora sp. (P 18) on different media.

Culture	Medium	Reaction
P1	Lima bean juice agar (a)	Colony covering whole surface of substratum. Aerial mycelium reaching lid of dish. Heavy white growth
P3	Lima bean juice agar (a)	Colony growth like P1 but for aerial mycelium which is less abundant
P4	Lima bean juice agar (a)	Essentially like that of P1
P18	Lima bean juice agar (a)	Heavy white growth extending over entire dish
P216	Lima bean juice agar (a)	Colony spreading over entire dish. Aerial mycelium loose fluffy
P1	Lima bean (juice extracted) agar (b)	Mycelium much more abundant than on lima bean juice agar. Colony covering whole bottom of dish
P3	Lima bean (juice extracted) agar (b)	Like P1
P4	Lima bean (juice extracted) agar (b)	Like P1 and P3
P17	Lima bean (juice extracted) agar (b)	Like P1
P18	Lima bean (juice extracted) agar (b)	Very heavy thick growth over entire dish
P216	Lima bean (juice extracted) agar (b)	Slightly less growth than P1
P1	Malt syrup agar (c)	Colony 1 in. in diameter, aerial mycelium scanty
P3	Malt syrup agar (c)	Colony 1¼ in. in diameter. Otherwise like P1
P4	Malt syrup agar (c)	Colony 1⅛ in. in diameter. Other characters like P1 and P3
P17	Malt syrup agar (c)	Colony 1¼ in. in diameter. Aerial mycelium scanty
P18	Malt syrup agar (c)	Colony 2 in. in diameter. Aerial mycelium scanty
P216	Malt syrup agar (c)	Colony 1[illegible] in. in diameter. Aerial mycelium present, stands out clearly unlike P18
P1	Malt syrup agar (d)	Colony 1⅛ in. in diameter. Little aerial mycelium
P3	Malt syrup agar (d)	Colony 1¾ in. in diameter. Little aerial mycelium
P4	Malt syrup agar (d)	Colony 1½ in. in diameter. Little aerial mycelium
P17	Malt syrup agar (d)	Colony 1[illegible] in. in diameter. Little aerial mycelium
P18	Malt syrup agar (d)	Colony [illegible] in. in diameter. Little aerial mycelium
P216	Malt syrup agar (d)	Colony 1¼ in. in diameter. More aerial mycelium than P1, P3 or P4
P1	Oatmeal agar	Colony covering entire surface of substratum. Loose mycelial growth
P3	Oatmeal agar	Like P1
P4	Oatmeal agar	Like P1 or P3
P17	Oatmeal agar	Like P1
P18	Oatmeal agar	Slightly heavier growth than P1
P216	Oatmeal agar	Like P1

(*a*) Lima bean juice agar. Made by boiling 60 grams of lima beans in one liter of water for 2 hrs. allowing the juice to boil down to 500 cc. after filtering. To this 10 grams of agar agar were added and then the medium prepared in the usual manner.

(*b*) Lima beans (juice extracted) after filtering the juice for the above medium the beans were boiled a second time in 500 cc. of water adding 10 grams of agar agar. This was not filtered.

(*c*) Malt syrup agar. Prepared like Leonian's (6) medium No. I except that instead of the dry malt extract we used malt syrup.

(*d*) Prepared like *c* but with 10 grams of malt syrup instead of 5 grams.

These pathogenes did not fructify well in any of the media. Non-sporulating 10-day-old cultures on oatmeal agar were set aside. The fruit fly (*Drosophila amphelophila*) laid eggs in them and larvae were found in the substratum a few days later An examination of the cultures at this time (cultures 18 days old), revealed the presence of numerous sporangia and chlamydospores A few oospores were also encountered Measurements of the three types of spores were made for taxonomic purposes

Summarizing the results which appear in table VI, it may be concluded that the differences between the different cultures on the various media are not enough to warrant a safe separation of the same into different strains or species It appears, however, that P18 differs enough from all the others to warrant its designation as a distinct form This will be confirmed with additional data on other reactions All the other cultures are much the same in their reactions on the above media

Pathogenicity The pathogenicity of cultures was tested in various ways In every case *Pythium* cultures which cause damping off in the seedbeds were employed as checks In the following paragraphs are presented the details of the pathogenicity tests

Method for inoculation of plants in the field and those growing in pots of sterilized soil—Six plants were inoculated with each one of the cultures The basal part of each plant was sterilized with mercuric chloride solution (1–1000) and then washed with boiled distilled water One of the "sand" leaves from each of three plants of each set was cut at the axil and a wound made at this place into the tissues of the stem Here the inoculum (a small bit of mycelium from 7-day-old oatmeal agar cultures) was placed The wound was then covered with a little absorbent cotton, and the whole wrapped with a piece of heavy paper The cotton was moistened with boiled water soon afterwards and on the following day. The remaining three plants in each set were similarly wounded and inoculated but this time away from the axil of the leaf

Test No 1—February, 1927 "Borinquen" (Connecticut Round Tip) plants growing in pots were used. They were healthy and vigorous and the flower buds were opening at the time of inoculation They were inoculated with the cultures P1, P2, P3, P4, P10 and P14 The P2 used here is a culture of *Pythium de Baryanum*, isolated from tobacco seedlings.

On March 4, 1927, all plants inoculated with P1, P3, P4, P10 and P14 had wilted. The wilting of the leaves was more complete and pronounced on the side of the plant in which the inoculation was

performed Browning and blackening had advanced up and down the stem considerably, about 6" above the wound and about 2" below it The symptoms were like those occurring in the field under natural conditions The plants inoculated with P2 showed no evidence of infection, only a slight browning or discoloration of the bark was apparent, but below it the wound healed and the plants continued their normal growth like in the check plants where no inoculum was placed in the wounds

Test No 2—Test No 1 was duplicated on March 9 on plants of the "País" type of filler tobacco with similar results

These tests proved the ability of P1, P3, P4, P10 and P14, to produce black-shank and the non pathogenicity of P2 in relation to this disease It was also demonstrated how varieties which are resistant under natural field conditions succumb to the disease when artificially inoculated

Test No 3, December 23, 1927 Healthy plants of the Porto Rico filler ("País") and "Borinquen" varieties from a field known to be free from the pathogene (in the Experiment Station grounds) were inoculated when about 18" high The cultures used were P1, P2, P3, P4, P10, P14, P16, P17, P18 and P20 The notes gathered on December 25 showed infection had been produced by any of the cultures except P2, P16, P18 and P20 as indicated by a pronounced brownish discoloration around the wounds in the former and only a slight discoloration in the latter The results of subsequent observations are tabulated below

TABLE No VII

Results of inoculations of "País" and "Borinquen" plants with various Phythophthora cultures.

	December 27 Leaves wilting		December 31 Plants wilting		January 4
	Borinquen	País	Borinquen	País	
P1	5 plants	4 plants	6	5	All dead
P2	No plants	No plants	None	None	All healthy
P3	3 plants	3 plants	6	[illegible]	All dead
P4	4 plants	4 plants	6	6	All dead
P10	[illegible] plants	5 plants	6	5	All dead
P14	4 plants	4 plants	6	6	All dead
P16	No plants	No plants	None	None	All healthy
P17	6 plants	[illegible] plants	6	6	All dead
P18	No plants	No plants	None	None	All healthy
P20	No plants	No plants	None	None	All healthy

The only difference between the reactions of the two varieties to the different cultures was a more rapid wilting of the "Borinquen" plants

The wounds of plants inoculated with the remaining cultures were

examined by removing the paper and cotton. All wounds had healed in those plants inoculated with P2, P16 and P20, while those inoculated with P18 showed a slight browning which progressed for about 1/4" beyond the cut cortex but there it stopped and the wound healed

Test No. 4; December 23, 1927: Healthy plants of the "País" and "Borinquen" varieties grown in pots in sterilized soil were inoculated with P216 and P217 cultures at the time of the opening of the first blossoms The plants were kept in the greenhouse Six plants received the P216 inoculum, six the P217 and six remained as checks in each case The results at the end of nine days (Dec. 31) showed P216 infected all the six plants of each variety, while those inoculated with P217 were unaffected as were also the check plants. The Florida organism (P216) is also able to produce black-shank in Porto Rico

It should be noted that one of the varieties used in the test, namely, the "País" was previously given as second in degree of resistance in Porto Rico

That the black shank pathogene is the cause of a damping-off of tobacco seedlings was proved by the following test and by others which will be given later in another publication on damping-off diseases

Test No. 5 Small tobacco seedlings and *Ricinus communis* plants about 6" high, growing on sterilized soil in the same pots were inoculated with each of the organisms on April 25, 1928, by transferring small bits of mycelium from 8-day-old oatmeal agar cultures to the growing tip and one leaf of each of two tobacco plants in each pot. A needle prick was made on the leaf blade, leaf midrib and bud for this purpose, and after the inoculum was placed in these wounds, the part was covered with cotton and moistened All the pots were covered with bell jars which had been previously sterilized by washing with a concentrated solution of mercuric chloride. The cultures employed were P1, P2, P3, P4, P16, P17, 18P, P20, P16 and the culture from Sumatra obtained through Mr C M. Tucker Daily observations were made until May 5th when the experiment was completed.

P1, P3 and P4 produced an early severe infection on the leaf, stem and bud The discoloration was slightly paler than that produced by P17 Infection proceeded from the inoculated buds down to the base of the seedlings Leaf infections occurred. The mycelium appeared to extend from the infected parts through the soil into neighboring tobacco and *Ricinus communis* seedlings which it killed.

Portions of diseased parts were examined daily for sporangia. It was found that under the conditions of the experiment few sporangia were formed, but the mycelium was abundant. Finally all the tobacco and *Ricinus* plants were killed.

The results with P17, P216 and the Sumatra culture were similar to the preceding except for the discoloration of the tissues which seemed darker with P17. Infection was slower in the case of the Sumatra culture.

With P2, P16 and P20 none of the large tobacco seedlings showed infection, while all the small ones readily succumbed to the disease. *Ricinus* seedlings reacted similarly to these cultures.

In the case of the seedlings inoculated with culture P18 there were a few small seedlings killed and only a small spot produced on an inoculated leaf on a larger seedling. This leaf spot finally ceased to increase in size. It did not seem of much significance.

This experiment proves that cultures P1, P3, P4, P17, P216 and the Sumatra culture (all *Phytophthora nicotianae*) produce both damping-off of tobacco and *Ricinus* seedlings and the black-shank disease of tobacco. The fact that the Sumatra culture did not produce as rapid infection as the others may be due to the age of the culture. It further shows that small seedlings of tobacco and *Ricinus communis* are killed when inoculated with P2, P16 and P20 (*Pythium de Baryanum*) and that large plants remain uninfected. Culture P18 (an undetermined species of *Phytophthora* from tomato) may cause a mild case of damping-off under certain conditions but is usually non-pathogenic to tobacco.

Test No. 6—Potted plants of two Porto Rican varieties of eggplant were inoculated with *Phytophthora nicotianae* cultures (P1, P3, P17, P216 and Sumatra), *Pythium de Baryanum* cultures (P16 and P20) and the undetermined Phytophthora sp. P18, on April 25, 1928. At the time of the inoculation these plants had reached the stage at which they start to send out the first flower bud.

Inoculations were made in each plant at the terminal bud and at the axils of the leaves. The terminal bud was injured about ¼″ below the unopened leaves and here the inoculum was placed. The wound was covered with absorbent cotton moistened with sterile water and covered with a glassine bag which was held in place with a gem paper clip. The cotton was kept moist for the first three days. At the axil of one leaf in each plant a needle prick inoculation was performed. A piece of absorbent cotton was wrapped around the stem and petiole and over the axil. This was also kept moist for three days. The two varieties of eggplant ("Fajardo") and ("Ca-

muy") here employed are non-commercial, but show a remarkable resistance toward the bacterial wilt Two plants of each variety were inoculated with each of the following P1, P3, P16, P17, P18, P20, P216, and the Sumatra culture and two plants kept as checks.

Observations were made every day The experiment was completed on May 3rd The results were as follows

P1 produced infection in the bud of the "Fajardo" plants while in the "Camuy" plants infection occurred in both buds and leaves. The fungus made a more rapid advance into the tissues on the "Camuy" plants than in those of the "Fajardo" variety A similar effect was produced by P3, P17 and P216 The Sumatra culture also produced infection but slowly

P16 and P20 produced a slight infection which soon stopped. P18 caused the death of the buds in both varieties and wilting of the leaves in the "Camuy" variety alone

The results prove that the two varieties of eggplant, "Camuy" and "Fajardo" are susceptible to infection by *Phytophthora nicotianae* (P1, P3, P17, P216 and Sumatra culture) and slightly susceptible to the *Phytophthora* sp., P18, when these plants are wounded and the inoculum is transferred to the wounds Under the same conditions *Pythium de Baryanum* (P16 and P20) did not seem to be able to produce vigorous infection The "Camuy" variety appeared to be slightly more susceptible to *Phytophthora nicotianae* than the "Fajardo" variety

From the studies on pathogenicity of P1 P3, P4, P10, P14, P17, (Porto Rican strains), P216 (Florida strain) and the Sumatra culture all are pathogenic toward tobacco There are no differences that would indicate them to be different strains, unless the slightly slower development of the Sumatra organism be so considered It has already been pointed out that this may be accounted by the age of the culture

Size of sporangia alone, then, is left as the only means in these studies to separate strains, if these exist If Tisdale and Kelley's (12) assumption that their pathogene is a strain of *P nicotianae* is valid we propose that the black shank pathogene from Porto Rico be regarded as a distinct strain of the same species

LIFE HISTORY

The life history of *P nicotianae* involves a sexual stage and two spore forms of an asexual stage

The primary cycles appear either as damping-off and lesions on seedlings in the beds or as lesions on roots and stems in large plants

in the field They may also take the form of a swelling up of the transplants before any roots are developed

PATHOGENESIS

Inoculation.—The main sources of inoculum are infested debris from plants left over from the preceding crop and infested manure. In all probability, the mycelium vegetates in those decomposing plant parts and crops of sporangia and conidia are produced from it at intervals. Again the primary cycles may be induced by the mycelium without the production of conidia or sporangia. It is also possible that germinating chlamydospores which are found in the soil in abundance, may produce an invading mycelium. Oospores also present in the soil and debris probably constitute an appreciable part of the inoculum.

Incubation.—Oospores have not been seen germinating but they probably give rise to a primary mycelium which in turn gives rise to invasion hyphae and sporangia or conidia. Chlamydospores have been seen to germinate by sending a number of germ tubes from their surface. Rosenbaum (9) failed to obtain germination of chlamydospores of *P. nicotianae*.

Germination tests of sporangia or conidia in Van Tieghen cells show that when mature these germinate readily. Sporangia from three week old oatmeal cultures were employed. In the early stages of germination the contents of the sporangia are quite dark and in a short while they seem to break up into spherical masses (Fig. 1). Shortly afterwards movement is observed inside. The fine membranes at the papillate ends break and the zoosporic masses begin to ooze out through the opening. The zoospores remaining inside the sporangium begin to move about violently until all have succeeded in reaching the papillate end and then make their way to the outside, leaving empty sporangial shells. The writer has not observed zoospores germinating *in situ* as seen by Tisdale and Kelley (12) for this species and by other writers for other species. These zoospores play the most important rôle in the production of secondary cycles. They germinate by means of germ tubes. Conidia germinate also by sending out one or several tubes. The contents of the conidia pass into the primary mycelium and finally the shell breaks up and disappears.

The infecting hyphae from the mycelium in the soil or that produced by chlamydospores and oospores and the germ tubes from conidia or zoospores, enter through the stomata, or penetrate through wounds made on the stems and roots.

Infection.—The invading hyphae o tubes penetrate the epidermal cells and from here the branching hyphae extend into the underlying cell layers. The cortex of stems and roots is soon destroyed. Infection is very rapid under extremely moist conditions combined with favorable temperature. The hyphae cause the destruction of the tissues in a short time. On the diseased parts, mainly spots on leaves and stem lesions at the surface of the soil, sporangia are abundantly produced. During cloudy weather and specially in low places they will be found in large numbers in the water which collects in small depressions in the ditches, such as are made by the heels of shoes. They are transferred to suscept parts and start the secondary cycles.

SAPROGENESIS

Phytophthora nicotianae lives in the soil as a saprophyte on plant debris, old tobacco stems or manure. It develops actively in these media and readily spreads through the soil. During its saprophytic existence it forms chlamydospores and oospores. In fact, it is not difficult to find oospores in the soil where the fungus is present.

Secondary cycles are initiated by conidia produced in the primary lesions.

PATHOGENESIS

Inoculation.—Sporangia, conidia and zoospores are carried by irrigation water or by water running down the ditches during rains to the suscept parts, lower leaves, stems and roots. They may be transported there by other agents, like tools, workmen, animals, etc. A common means of transportation of the inoculum is by laborers who perform the weeding of the seedbeds. Spattering rain usually carries the inoculum over to the surface of the leaves. After the inoculum reaches the suscept parts it produces infection in the manner described for the primary cycles.

EPIPHYTOLOGY

According to Tisdale and Kelley (12) the minimum soil temperature for the black shank fungus is probably below 20°C. Unfortunately, we are not equipped to make soil temperature experiments. Consequently, the determination of the range of temperature for this pathogene could not be made. All that we can give at this time is merely based on observations made during the last two years. As has previously been pointed out, an outbreak of black-shank occurred in two fields of tobacco in the summer of 1927. This is the period of highest temperatures. On the other hand, the disease is

prevalent throughout the tobacco growing season, October to March. Plants inoculated at all times of the year have contracted the disease if moisture was adequate The fungus will cause damping-off of seedlings in any month of the year, provided the soil is kept moist. Moisture, then, is the most important and dominating environmental factor in Porto Rico In years where there are frequent but not heavy rains there are fewer cases of the disease Moisture seems essential for the production of sporangia, for their germination and for dissemination of the inoculum in general Standing water is especially favorable for spores to germinate

CONTROL

According to Tisdale (10), "the black-shank organism persists in the soil at least five or six years after tobacco culture has been discontinued on infested land" This makes the possibility of control through rotation of crops rather unfeasible In Porto Rico the best tobacco lands are kept under tobacco culture year after year and it seems unlikely that this practice will be abandoned in the future We must seek then, some other means of control, either preventive or eradicatory Eradication through removal of diseased plants from fields as soon as they are detected is always a good practice to follow Once plants become infected it is the only safe thing to do Seedlings which show lesions as described in previous paragraphs should be destroyed Such plants when transplanted will sooner or later succumb to the disease Transplants should be scrupulously selected The eradicatory measures for the damping-off produced by *P nicotianae* will be discussed in another publication

Tisdale and Kelley (12) consider the steaming of soils as impractical because of the high cost They report a case in which the treatment was only effective for one season In Porto Rico absolute sterilization to last for more than one season would be improbable. Drainage and irrigation water will carry the inoculum from one field to the other

Preventive measures may be of some value The treatment of plants with chemicals to protect them from black-shank may not be altogether practical Tisdale and Kelley (12), using Semesan at the rate of 80 lbs to the acre and inoculated sulphur at the rate of 360 lbs. to the acre were able to keep the disease in check on transplants up to about 30 days; but at the end of 90 days all the plants were diseased in the latter and about 99 per cent in the former case. Tisdale had already reported in 1923 (10) negative results in treatments of plants in rows with 2–2–50 and 4–4–50 Bordeaux mixture.

We have made tests with 5-5-50 Bordeaux mixture on "Ceniza" plants in pots. The soil for these was prepared with about 50 per cent manure and 50 per cent loam. All pots were first infested with actively-growing cultures of *P. nicotianae* (Porto Rican isolations). In one set of 25 pots the treatment was made a week before the seedlings were planted and a second set of 25 plants, at the time of planting. Notes were taken at short intervals. On November 24, 1927, treatment of the first set of plants was made by soaking the soil well with the mixture. The soil was again soaked fifteen minutes later A week later, healthy seedlings were planted in the pots of both sets and the first treatment of the second set made. At the end of the second week a second application of the mixture, equivalent to about 1 gallon per square foot of soil surface, was applied in the pots of the plants which were still healthy. By January 4, 1928, forty-eight plants in both sets had died and the two remaining ones showed typical black-shank symptoms.

From these results it appears that two treatments of Bordeaux mixture of as high a formula as 5-5-50 does not prevent black-shank in infested soils. No injury was produced on the stem or leaves by the Bordeaux mixture Tisdale (10) reports injury to the lower leaves by a 4-4-50 Bordeaux mixture.

There is another way of preventing the disease. When healthy seedlings are pulled from fields where there is an infection of damping-off the seedlings should be dipped in Bordeaux mixture (4-4-50 or 5-5-50). That this treatment is effective has been proved in the following experiment. Three hundred apparently healthy plants from a seedbed with infection of seedling rot or damping-off were dipped for one minute in a 4-4-50 Bordeaux. They were planted in a garden (supposed to be free from the pathogene). Three months later there was not a single plant with any symptoms of the disease. The bed from which the seedlings were taken had been previously infested with the black-shank pathogene and slightly protected by an unsuccessful copper treatment.

Control by breeding and selection of resistant strains of tobacco.— In Florida, Tisdale and Kelley (12) report progress made in the development of resistant strains of Big Cuba Tobacco. Selection and crossing experiments have been made in Java with a similar aim, D' Angremond (4).

We have looked toward the breeding of tobacco varieties in Porto Rico as the most effective means of attacking the disease problems. However, work in tobacco has certain aspects of its own. A plant

whose commercial value is dependent entirely on the quality of its leaf is certainly difficult to handle. The breeder naturally faces great difficulties To think that the quality of a plant part so variable as the leaf is, must possess a certain degree of uniformity, and that this "quality" consists of desirable color, texture, taste, burn and aroma Again the "tastes" for a certain color are also variable The demand for different shades of color in the wrapper may be different in different years Then to go back to the environment and realize how susceptible is the tobacco plant to it, that "quality" must vary with the type of soil, fertilization, intensity of sunlight, altitude and the region Other factors, are not considered here which would apply to all types of tobacco

The problem then in Porto Rico would be which variety to grow for a certain soil and region and with the desirable resistance to *P. nicotianae* together with the essential qualities enumerated above

Among the Porto Rican types of tobacco there is one which shows a high resistance to black shank as already stated Fortunately, this type (the "Puerto Rico" wrapper) has been properly selected by the Porto Rican Leaf Tobacco Co This type has given excellent results in the 1927-28 crop Promising results have been shown by other resistant strains of tobacco, originated from crosses made by that Company in recent years There is every indication that these selected strains will go a long way toward solving the disease problem for the moment Work must be continued in the selection of those types

When our preliminary observations early in the season in 1926 showed us that there were certain varieties of tobacco which normally would not show much black-shank, it was arranged to start some crosses between those and other more desirable, but susceptible varieties or types

Crosses were begun that year and the first generation was grown in the summer of 1927 followed by the second generation in the fall of the same year Crosses were as follows:

"Vuelta Abajo" × "Borinquen"	(direct and reciprocal)
"Vuelta Abajo" × "Ceniza"	(direct and reciprocal)
"Vuelta Abajo" × *Consolation*	(direct and reciprocal)
Expt Station × "Borinquen"	(direct and reciprocal)
Expt Station × "Ceniza"	(direct and reciprocal)
Expt Station × *Consolation*	(direct and reciprocal)
Expt Station × "Vuelta Abajo"	(direct and reciprocal)

The *Expt Station* × "Borinquen" crosses were discarded in the first generation because of high susceptibility to black-shank.

Some apparently good individuals were selected in the second generation of the remaining crosses. They were selfed and the seed has been kept for the third generation to be grown in the fall of 1928.

SUMMARY

1. A disease known in Porto Rico as 'pata-prieta" and probably the same as the black-shank from the Southern United States and the "Lanas" or "bibit" of the Dutch East Indies has been destructive in Porto Rico during the last few years on tobacco

2 The pathogene which is responsible for this disease may also attack *Ricinus communis*, potato plants, pepper, tomato and eggplant seedlings under certain conditions in Porto Rico

3. A non-commercial variety of tobacco (mammoth type) proved to be the most susceptible of all varieties to the malady Of the two important commercial cigar-wrapper varieties in Porto Rico, one was found to be very susceptible and the other very resistant, while all the cigar-filler varieties were slightly susceptible New strains of a Porto Rican variety of cigar-wrapper tobacco have exhibited a high resistance

4. First generation populations of crosses between a very susceptible variety and other susceptible or slightly resistant types were very susceptible to the attacks of the pathogene On the other hand, those crosses of resistant varieties with susceptible ones were more resistant than the susceptible parent

5. The symptoms of the disease are produced on plants of all ages. A bed rot and seedling blight, a rotting of transplants, a blackening of the basal parts of the stems of plants of all ages and a leaf spot on big plants, are the most important morphological symptoms.

6. The causal organism also produces a severe rotting of seedlings in the seedbeds

7 The black-shank pathogene was the cause of a disease of trans plants called "hinchado" (water-soaked or swollen).

8. The causal pathogene is here given as *Phytophthora nicotianae* Breda de Haan The organism from Porto Rico appears to be morphologically different from that of Florida The Porto Rican fungus is, therefore, considered a different strain The Porto Rico and the Florida strains were not compared culturally or morphologically with the strain from Sumatra.

9. The Forida strain does not differ from the Porto Rican strain essentially in cultural characteristics or in pathogenicity.

10. The size of chlamydospores is of no value in the separation of the strains. Use was made only of the size of sporangia.

11. Moisture is a dominating factor in outbreaks of damping-off caused by the black-shank pathogene.

12. Irrigation water is an important agent in the transportation of the pathogene from one field to the other.

13. *P. nicotianae* lives in the soil as a saprophyte on plant debris, old tobacco stems or manure.

14. As control measures are recommended: (*a*) the *removal of* diseased individuals, (*b*) the rigid selection of seedlings before setting out in the field, (*c*) the dipping of healthy seedlings obtained from a diseased bed in a 4–4–50 or a 5–5–50 Bordeaux mixture before transplanting, (*d*) the selection and breeding of resistant varieties.

15. The treatment of the soil with Bordeaux mixture was not effective in preventing the disease.

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EXPLANATION OF PLATES

PLATE VI

Fig. 1. Sporangia of P3.
Fig. 1–A. Sporangia of P3 germinating.
Contents breaking up into spherical zoosporic masses.
Fig. 1–B. Empty sporangia shells.
Fig. 2. Sporangia of P 17.
Fig. 3. Sporangia of P 1.
Fig. 4. Sporangia of P 216.
(Sporangia essenially alike.)

PLATE VII

Fig. 5. Chlamydospores of P3.
Fig. 6. Chlamydospores of P 1.
Fig. 7. Chlamydospores of P 17.
Fig. 8. Chlamydospores of P 216.
Fig. 9. Oogonia and Antheridia of P17.
Fig. 10. Oospore of P17.
Fig. 11. Oospores of P3.
Fig. 12. Oospore of P 216.

Plate VIII

Fig. 13. Mycelium of P3.
Fig. 14. Mycelium of P216.
Fig. 15. Mycelium of P1.
Fig. 16. Mycelium of P17 (Note some fertile branches).
Fig. 17. Mycelial threads in xylem cells.
Fig. 18. Epidermal cells of *Nicotiana tabacum* in tangential section showing the invading hyphae.

Plate IX

Figs. 19, 20, 21 and 22. Lesions in seedlings. Note that infection has occurred just above the surface of the soil in figs. 21 and 22. In figures 12 and 20 infection occurred at the petioles of the leaves.

Fig. 23. A full grown plant in the field severely affected with the disease. All the leaves are yellow and shriveled.

Fig 24 Three medium-sized plants in the field. The one on the left is completely wilted; that on the right has recently contracted the disease (note the wilted lower leaves).

Plate X

Figs. 25, 26, 27 and 28. One-half natural size. These show the characteristic black-shank lesions at the base of the plant. Note the poor root system. The arrows point at the uppermost limit of the lesions. In figure 26, infection occurred at the leaf blade and followed down the petiole and stem.

Fig. 29 The same plant as in figure 28, much reduced. (Note shriveled condition of foliage).

Fig. 30. Same plant as in figure 26 (much reduced). Shows both the lesions at the base of the plant and the wilted leaves.

Plate XI

Fig. 31. A field of tobacco under shade. The variety here is the non-commercial mammoth type, a very susceptible variety. The majority of the plants have contracted the disease at this stage.

o-O-o

PLATE VI

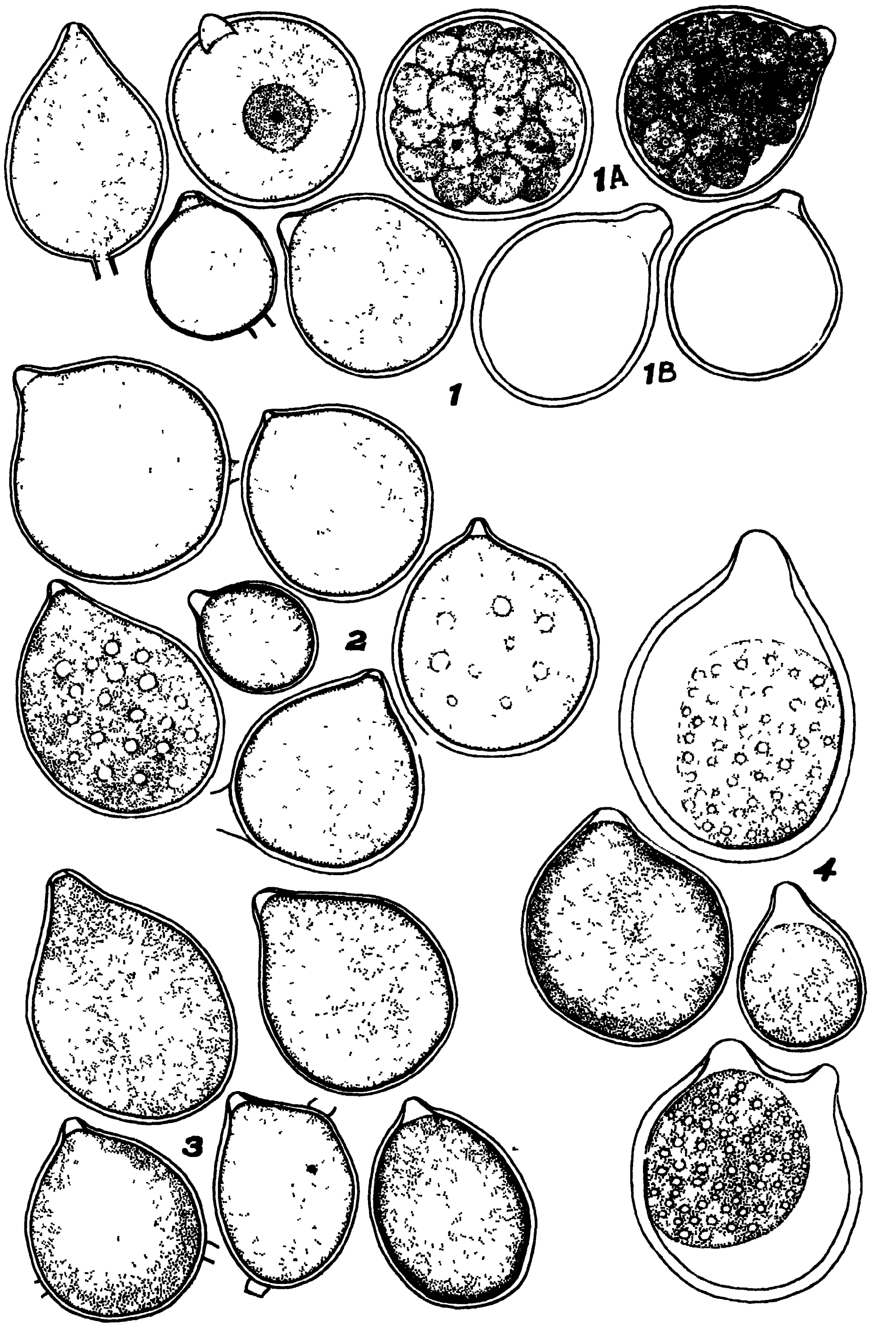


PLATE VII

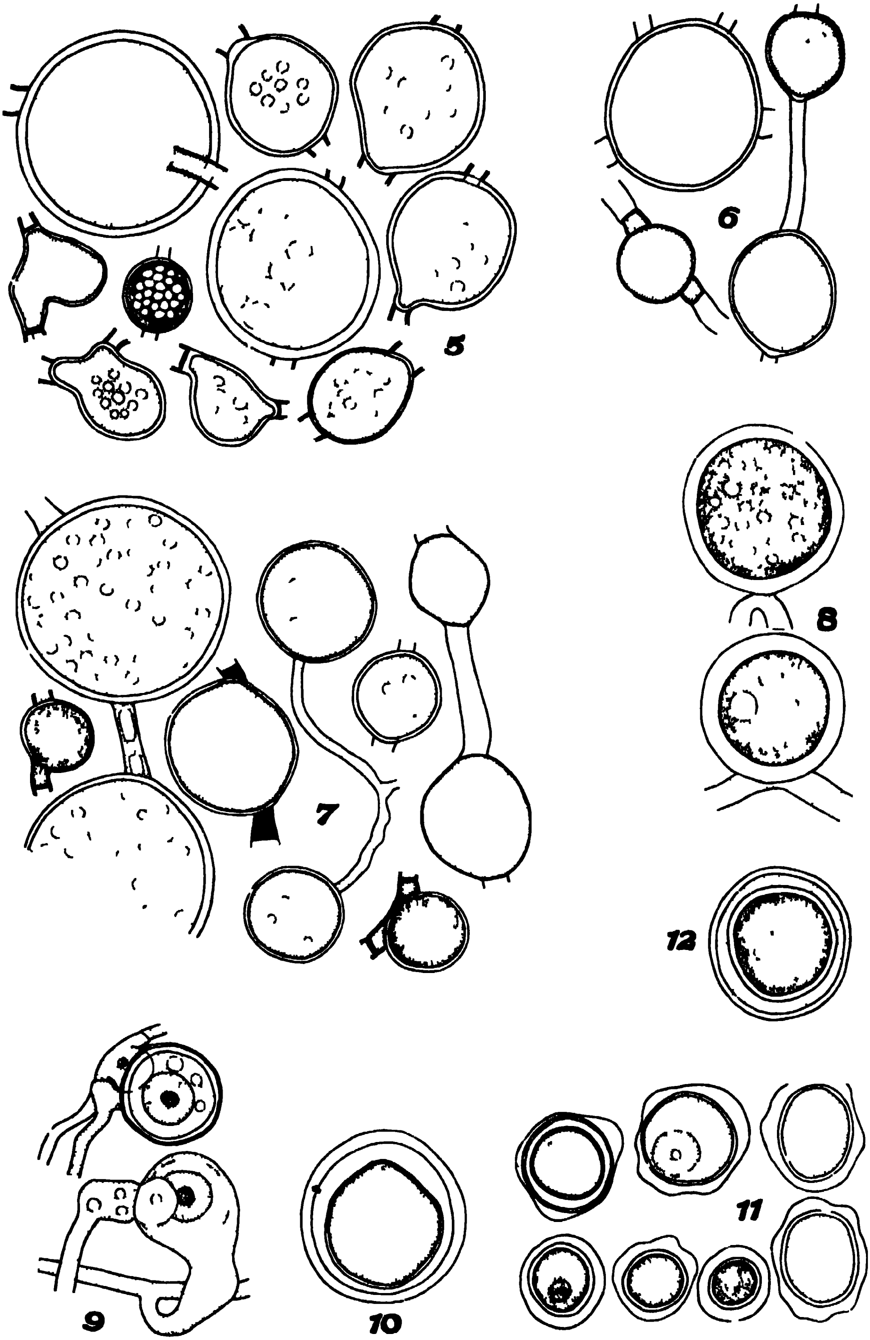
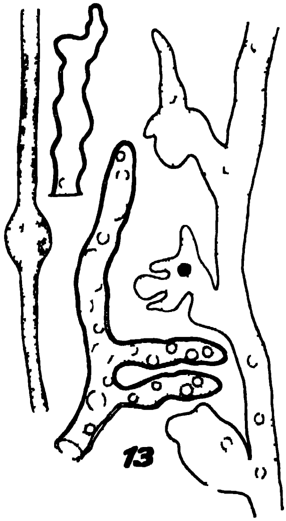


PLATE VIII



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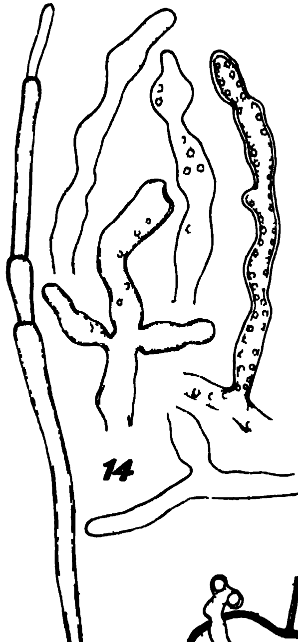

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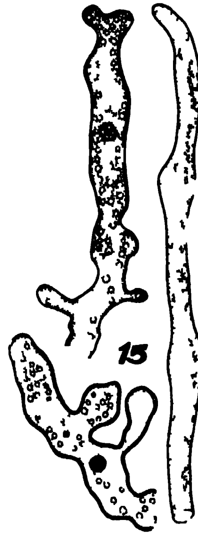

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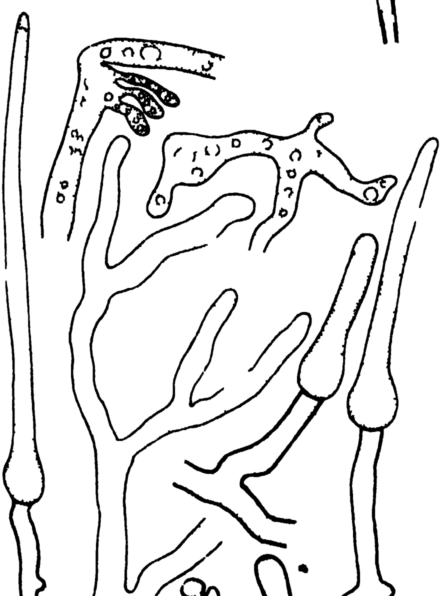

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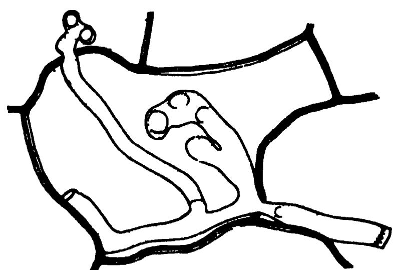

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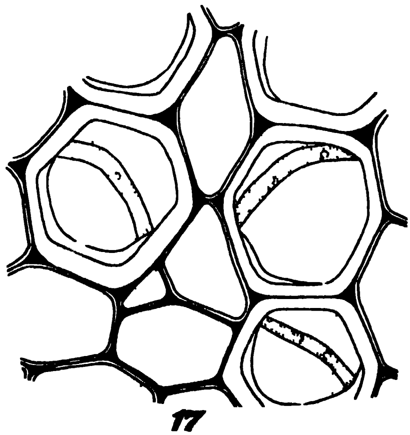

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19 20 21 22 23

PLATE X

25 26 27 28 29 30

PLATE XI

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